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British Society for the Study of Orthodontics. 1923.

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TRANSACTIONS

OF THE

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1923

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THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

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British Society for the Study of Orthodontics.

An Ordinary Meeting was held on Monday, Jan. 15th, 1923. Mr. W. Warwick James, President, in the Chair.

The President announced with deep regret the death of Sir Francis Farmer, and proposed that the Secretary should write to Lady Farmer expressing the sympathy of the Society with her in her great loss.

This was carried in silence, the members standing.

The minutes of the previous meeting were read and confirmed.

The following new members signed the Obligation Book and were formally admitted to membership: Mr. J. F. Howard Clarke, Mr. V. F. Sargent, and Mr. R. M. Pearce. Mr. H. A. Coysh was elected a member.

The President said the agenda of the meeting had been altered by omitting the paper on "Mouth Breathing" which was to have been read by Mr. Davis. The paper would be read at the next meeting; it was felt that there would be so little time for discussion if taken that evening having regard to the fact that there were other items also on the agenda, his own Presidential address, and a Report from the Hon. Secretary on his visit to France. One reason for the change was that he should like to take the unusual course of having his address discussed.

The President then delivered his Presidential address.

A THEORY OF ERUPTION.

You have done me the honour to elect me as your President for the ensuing year, and although fully aware of my many deficiencies for occupying such a post, I will endeavour to serve you to the best of my ability.

Orthodontics as a science or an art in its beginnings concerned itself almost entirely with the appearance of the patient, and clinically, or for teaching purposes was known as "the treatment of irregularities of the teeth." Attention was directed to the position of the incisor teeth, particularly those of the maxillæ. Many of us commenced our dental studies at the end of this period, which was most unsatisfying, and the ruthless extraction of teeth, particularly the first permanent molars, was most depressing. The next phase concerned itself with function; the relative value of all the teeth was emphasised, the importance of occlusion was recognised, and a great change resulted. It may be that men in different parts of the world had contributed to this progress, but it was the American dental surgeons who mainly effected the change. Function became the prime consideration with a few, but the public will never allow appearance to be disregarded, and probably it will hold first place to the end of time. The foulest mouth can await treatment, but a blemish upon an incisor will bring a patient any distance and at great inconvenience in the shortest possible time!

In spite of the public, the importance of function was recognised by the orthodontist to be greater than that of appearance. It was about this period that the condition of the teeth became widely appreciated as affecting the general health of the individual. For the purpose of appearance, function and good health, it has become the aim of the orthodontist to establish the teeth in normal position in the dental arches and in correct occlusion.

It was believed that the teeth could be regarded as normal for the particular individual possessing them, i.e. they were not too large or too small, and that their correct arrangement would give the best possible result, both in appearance and function. Apart from the size of the teeth the normal conditions frequently present rendered the mere arrangement of the teeth in correct position and occlusion insufficient; we were driven to consider the development of the whole individual, and this consideration will have to be the basis of the conception of our work in the future. The study of developmental changes which affect the jaws has commenced, and it is along these lines that we must work. We are moving gradually from the procedure of correcting malpositions which are established to the treatment of conditions which cause the displacements. The dentist or orthodontist did, and in many cases still does fix his attention too closely on the teeth, and often still will wait until malposition of the permanent teeth exists before commencing treatment. For instance, it is possible to predict with certainty what will happen to a child of five years with no separation between the incisors, and particularly so when those of the mandible are almost hidden by those of the maxillæ when the teeth are closed. The age of five is late, but at this age the most inexperienced can recognise the absence of spacing of the incisors, the absence of marked attrition on them, and that the mandible has not assumed its normal development, which if most complete has brought the incisors to an edge-to-edge occlusion.

(NOTE.—As I have named five years, I ought to say that I believe it is possible to predict imperfect development at a very early age, in fact, at the stage of eruption of the second temporary molars, the indications may be such that the treatment should be undertaken.)

Without further analysis, the third phase might be described as development. When our knowledge of the normal for all periods of life is established, it will be possible to recognise the cause which produces deviation, and it may be that in many cases the former may be acquired through study of the latter. The point of importance is: "When did the deviation from the normal occur?" Recently a most interesting and important paper was read before this Society by Sir Arthur Keith and Mr. George Campion. It contains much food for thought, and should be studied carefully by all our younger members, skull in hand. When reading this paper, and with this small skull in my hand, I recalled some former thoughts which led me to work upon eruption. My process of reasoning and my conclusion already recorded, badly I am afraid, may interest you.

The position of the crowns of the permanent teeth in the skull prior to their eruption is remarkable. At first glance, they appear to have no systematic arrangement; comparison with other such skulls shows the arrangement to be normal to all, perhaps in fact, more frequently so than at a later date. A careful examination reveals several points of interest; the crowns of the teeth correspond closely with an irregularity commonly seen in the maxillæ, the small base of the arch, the central incisors in front of the laterals, the high canines and later the great curvature of the occlusal surfaces are the most noticeable features; also the closeness of the calcified teeth (only the crowns for the most part) to the floor of the nose and

to the lower border of the mandible. But the most remarkable fact, and the more I thought about it the more remarkable it appeared, is that each of these teeth will erupt on the surface at a point from which it most rarely deviates ; the abnormal or pathological conditions are rather those of non-eruption than deviation from the point of eruption. What factor could bring about with such certainty the eruption of a tooth at a definite point ? Denudation from above with growth below will account for many conditions which arise, particularly the persistence of the arrangement of the teeth prior to eruption referred to above. Denudation will account for the completion of eruption, also the removal of the temporary teeth and their alveolus. If we imagine the growth which must take place to accommodate the roots of the teeth as occurring *en masse*, the teeth must be moved in a direction away from the floor of the nose in the maxillæ, and away from the lower border in the mandible. Denudation will go a long way in explaining eruption, but advancement of teeth certainly takes place, for two teeth of unequal level later approximate much more closely, e.g. a first molar and a second premolar. The most probable theory I could formulate was that the epithelium which had connected the tooth germ with the surface epithelium still persisted and that Magitot was wrong in stating that it is lost. On cutting sections of jaws prior to the eruption of any teeth, there was no doubt that epithelium was present, but was it only scattered and merely remains of the broken up tooth band as stated by Magitot ?

Eruptive force is accepted as a fact, and by the majority is interpreted as a force carrying each tooth to its position ; it is sufficient, I think, to regard the growth of the tooth with the surrounding bone as sufficient to account for local eruption if denudation occurs. Before commencing this investigation, eruptive force was a fact in my mind, and I wondered why teeth did not erupt at any other point than on the alveolar ridges. The shortest route to the surface was not always the normal site, why did this route escape ? I decided there must be a directing factor. On cutting serial sections through the jaws, I found a continuous column from the tooth germ to the surface epithelium. The column, although often tortuous, was present in every specimen of serial sections examined ; I felt satisfied this must be the directing factor I sought. The connecting column of epithelium undergoes a remarkable change as the period of eruption approaches ; the cells near the surface proliferate and undergo keratinisation ; peculiar collections which I named " epithelial coils " (globe malassez epidermique) are found, and on the actual surface the proliferation is most marked where the cells are continuous with those of the epithelium of the mucous membrane. A notch can be seen quite clearly. I came to the conclusion that eruption was due to growth both in the vertical and lateral planes, the latter being associated with opening out of the tissues over the tooth, on the surface, and along the line of the epithelial column.

I did not wish to tire you with my views upon eruption, but I would suggest that investigation of a question which suggests itself in a like manner to the one presented to me—why do teeth always erupt on the alveolar ridge ?—and which caused me to try to investigate the subject, may not be ignored by you, and that an effort will be made to answer the question. I appeal to our younger members particularly.

Discussion.

Mr. Schelling asked whether the epithelial cells were the cause of the absorption which occasionally was found on the side of the root of a permanent lateral eroded by a down-coming canine—whether it was an absorbent action as well as a guiding action ?

The President did not think the cells had any action in that way ; he did not think they were cells capable of producing absorption. In the calcified tissues the cells that would absorb a tooth were almost certainly of the nature of osteoclasts. Probably cells were present in granulating tissues which would produce absorption. Very little was known about absorption of temporary teeth and that was a matter that might excite the interest of many of the younger members who might probably make a valuable contribution on the subject. It meant not only absorption of teeth but absorption of bone. He had no right to say that probably they were similar in action, but he imagined it was so.

Mr. George Northcroft asked if the President would develop a little his idea of eruptive forces which he had taken as an accepted fact, but did not quite explain what the force was or exactly how it acted. The term force was very often used rather loosely to express different ideas. It seemed to him that in addition to the opening of the way and the guiding of the way by the epithelial columns, the President had also added the necessity of there being some *vis à tergo* which made the tooth come up through the easy channel, and that required explaining a little further.

The President said apparently he had not made himself quite clear. He rather derisively spoke of the eruptive force. In speaking of the eruption of teeth the idea usually conveyed was that the tooth actually moved through the tissues, but he did not believe it did move through the tissues at all. His idea was that the tooth practically remained in its position with regard to the neighbouring tissues but was carried into position with them. There was the lengthening of the root, the growth of the bone around the root, and all these tissues were moving away from the lower border of the mandible or the floor of the nose in the maxillæ. If a young skull is examined one is impressed by the lack of space for the roots. Bone must be laid down and all that growth must be from below. It was known that the temporary teeth and alveolus were lost and at the same time with growth from below and denudation from above the teeth took up their position. There was no pushing at all of the teeth through the tissues. If there was any pushing it was really the growth of bone and the root of the tooth carrying the crown of the tooth further. It seemed as if that must occur in premolars to some extent. The growth of bone around the premolar root must be very active. If the jaws of a child were examined just before the first permanent molars were exposed, the gum tissue should be found to be in occlusion. He had actually seen the cusps just perforating the mucous-membrane almost in occlusion. He believed that was the normal process in the most perfectly developed jaws. In connection with the molars, a great deal could be accounted for by growth and absorption and denudation. It was difficult in connection with premolars and also with the central incisors, which one day could be seen of a certain length and another day more exposed and if carefully watched it would be seen that it was by the tissue being removed as well as by advancement. It was a complex subject, but that was the interpretation he had put upon it. He believed eruptive force was a wrong term. If sections were cut it would be seen that with advancing age the tissue was getting thinner and yet the relations of the tooth and epithelium remained much the same. The relation of the tooth to its neighbouring tissues did not alter, in his view.

Sir H. Baldwin said that taking the upper canines which were high up and embedded it was known that the crown of the tooth must travel through the tissues to get into place, and it could not be all due simply to the lengthening of the root. Whether the part corresponding to the tip of the root moved down also might be a question, but that

the crown moved was known to be a fact. Very often when a permanent tooth was delayed in eruption it was known that it would come down and in time take up its proper position, having obviously travelled down between the teeth on each side of it. Often when a lower second temporary molar was retained beyond its proper time it would remain at a very much lower level than the permanent teeth which came on each side of it, showing probably that the permanent teeth and their alveolar process had grown up considerably above their original level. There was also a great deal of addition to the bone of the jaw, which thickened beneath where the roots used to be. The lower jaw thickened very much and probably also the alveolar process was added to at its edge and in that way it was easy to account for the permanent teeth getting into a higher position. He remembered seeing an adult patient some time ago who had retained the temporary first incisors in the jaw, and they were at a very much lower level than the permanent lateral incisors which were next to them, showing that a large amount of bone had been laid down. He did not think it was possible to get away from the fact that the teeth did actually move through the tissues. He did not know whether the President had any opinion on Mr. Constant's theory of the pressure of the vascular bag pressing the teeth out and causing eruption.

The President said the matters mentioned by Sir Harry Baldwin were of great interest because they were things which had to be considered very carefully. The canine did lie right up above. If denudation took place with only a small amount of development those teeth practically retained the same position; the canine would be found above, the laterals inside the arch and the centrals crowded together in a very small maxilla. That recurred in connection with the non-development of the nose and centre. His point was that the tooth did not move relatively to the tissues alongside it—that the growth took place carrying the tooth with it. The bone was growing and the root was growing and all the tissues were brought into position by growth. The force, for instance, of blood pressure was equal in all directions; it was very difficult to conceive that the pressure on the bone was that of the blood pressure. It followed Newton's law of action and reaction. Blood pressure actually existed in the whole of the body. He did not think it was conceivable that vascular pressure could drive a tooth through tissue which had the same tension. With regard to retained temporary teeth being below the level of the permanent teeth, he thought that was rather an argument in favour of the growth of bone and the tissues that had taken place in a normal manner. As Sir Harry Baldwin had said, it was obvious that there was a very great growth of bone and there was the lengthening of the root that was occurring concomitantly with the growth of the surrounding tissues. When the crown was actually exposed it looked as if local growth must be such that it would carry one tooth a certain distance, but he attributed it to the growth of the tissues and not the actual movement of the tooth through the tissues in which it was lying. He might be wrong, but on examination of a large number of sections he always found that the cap of the epithelium was just the same over the crown and neighbouring tissues while active growth was taking place. It was difficult to grasp the two factors going on at the same time, one the progression of growth and the other removal of the tissue. Few people would deny the completion of eruption by denudation when the small tags of gum around the tooth were removed largely by means of mastication. The gum became quite thin and closely attached below the bulge of the crown. If the mastication was imperfect the mouth never got to that stage of perfect eruption, there remained little tags of tissue and the tooth could be described as imperfectly erupted. From some investigations he made with Mr. Pitts at Gt. Ormond Street he was able to record the dates of eruption of teeth and classify the teeth into about five different groups. They had taken the teeth of 4,800 children and marked them off in degrees of complete eruption. The minus mark was put where they felt it was

short of eruption, three dashes for about two-thirds of the crown through, two dashes for one-third of the crown through, and one dash for just showing. The difficulty of complete eruption was so extraordinarily difficult that often they were puzzled to say whether a tooth was completely erupted or not. As far as denudation was concerned, in the completion of eruption he thought most people would agree that the final eruption was due to denudation of the gum over-lying the tooth. It was a difficult matter to break down the idea that the tooth did not move. The whole conception of an eruptive force driving a tooth through the tissues into position he believed was wrong.

Mr. SCHELLING asked whether it was not somewhat analogous to the way students had always been taught that sharks' teeth came up, like a blind on its roller, over the top of the jaw.

The PRESIDENT said in the shark's tooth there must be growth from behind and absorption from in front. He had never carefully examined sharks' teeth or cut sections of them, but he imagined that the teeth were coming up from behind and that the tissues carrying them must undergo absorption in front.

Mr. NORTHCROFT said he would be willing to accept the converse of the President's statement in the case of the non-eruption of a canine, and he asked the President whether he would consider that the non-eruption of a canine was probably due to the absence of the epithelial column where there was a full grown tooth with a fully developing root. Would the non-eruption of such a tooth be accounted for, according to the President's idea, by the absence of the epithelial column.

The PRESIDENT thought that would go a long way towards establishing the point that the teeth which were not erupted had no epithelial column. It was very difficult to answer Mr. Northcroft. That epithelium occurred around the crown of the unerupted canine was certain and it very often went on to degenerate and to produce a dentigerous cyst. It was possible that if growth could take place in one direction or another a tooth could be displaced, but it was extraordinarily rare.

Mr. HOPSON said he had always understood and been taught and had taught that in the case of a shark's tooth the main structure of the jaw was cartilaginous, but there was a small bony tissue in the front in relation to the tooth. In addition to the tooth coming forward and rolling up over the roller, as Mr. Schelling had described, there was always taking place at the site of eruption some absorption of the little bony edge, which was followed by a deposition of new bony tissue there. Whether that in any way exercised a sort of drag on the tooth he was not prepared to say, but he thought he could grasp what the President had been endeavouring to impress upon the meeting and he was largely in agreement with him in his main idea, that when a tooth was formed, there was, from without inwards, the cementum, a very thin layer, and attached to that the tooth follicle or periodontal membrane was beginning to form and was attached on the outer side to the wall of the crypt. Then there was a considerable amount of denudation of the overlying tissue. He was in agreement with the President that probably concurrent with that denudation there was what he should like to call a sort of lifting of the developing tooth and that lifting part brought about a growth and the surrounding hard tissues had lifted with them the soft tissues and so the whole thing went up, locally in some instances. The illustration given by the President of the opening up of a book was, he thought, absorption of the surface to make way, following up the epithelial column, then a deposit of bone and removing the soft tissues surrounding the root of the tooth, and then the opening out. Taking another analogy, the teeth of the manatee travelled forward in a most extraordinary manner from the back to the front. Looking at the mandible of a manatee from behind there was the very remarkable fact that the teeth were large in the alveolar bone, which was perfectly distinct from the true bone of the mandible itself. It was in a little tube, as it were, and the last couple of teeth were sticking out behind. Looking

at any sections through the jaw of an animal like a snake, and seeing the number of successional tooth germs present, one would say that they were not in a straight row but went down and up again. The movements of developing teeth in a snake before they erupted were most extraordinary. The epithelial columns were in a most extraordinary position if they were the line which the teeth followed. He took it that the President meant that the column of epithelial cells gave the tooth a direction in which it was going to erupt. Was it a direction of least resistance through the epithelial columns? In misplaced teeth, or canines erupting into the nose, the line of epithelial columns had become extremely out of place; cases could be seen where the third molar erupted into the coronoid process, he had seen one himself and wondered how it had been lifted into that extreme position. Was there a line of epithelial cells going up and round into the coronoid process? It was a delightful speculation which might be discussed for a very long time.

The PRESIDENT said epithelial coils occurred particularly near the surface of the epithelium, and he thought it was an opening out at that point; the connecting epithelial column was the factor of importance. His idea was that the tooth did not actually move along that column of cells at all, but that the whole process was the opening out from above down to it, whilst the tissues were carried upwards by the growth around the tooth and that from above the denudation occurred, and the epithelium was never lost immediately over the surface of the tooth. With regard to a tooth being displaced, he should like to be quite sure that a tooth erupting into the nose had not been associated with any pathological process. Those he had seen had nearly always been associated with some pathological process, either some inflammatory changes or by association with a dentigerous cyst. He should like to know whether the one Mr. Hopson saw in the coronoid process had a cystic cavity associated with it.

Mr. HOPSON said he did not know whether there was a cystic cavity. Infection had certainly occurred around the tooth at some time because attention was drawn to a sinus which had persisted for a number of years. He recorded the case at the Odontological Section of the Royal Society of Medicine some four years ago.[1] A good deal of absorption from the tooth had taken place although it had been buried all the time. He saw the case during the war.

Sir HARRY BALDWIN said that both the theory of the President and Mr. Hopson seemed to imply a sort of bone current, which did not accord with the old-fashioned opinions of the growth of bone. Bone in changing its shape had to be absorbed at one part and added to at another part. He could not imagine such an internal change taking place in bone as would be necessary in some cases.

Mr. HOPSON said his point was that bone was built up only when teeth were formed and was subservient in every way to the teeth. It was built up especially to support an individual tooth. He had a case of a young Hindu who never had any teeth at all. He had a small mandible and a little maxilla like a small child's; there had been no alveolar growth at all. With the growth of the alveolus there was a gradual lifting up, in that region, of the soft tissues surrounding the developing tooth, bringing it up to a certain extent, and there was denudation from above.

Dr. SIM WALLACE asked whether the growth of an elephant's tusk was the production of *vis à tergo*.

The PRESIDENT understood that the molars definitely moved forward and were gradually lost by movement. In the incisors it might occur by growth of the tissues around the base. He thought most people would be in agreement that the actual fibres attached to the root of the tooth went with the tooth. If that was so, one had to think of the tooth actually moving through the tissues immediately surrounding it. One could conceive of the crown moving through, but it would be necessary to think of the root moving through the tissues as well. Sir Harry Baldwin had pointed out that the temporary tooth remained

below the level of the others, the explanation seemed to be that the teeth around it had actually developed. With regard to the development of the elephant's tusk, his knowledge on that subject was insufficient as he had not made an examination of these teeth.

Mr. Lewin Payne asked what explanation there was as to the eruption of a premolar with its lingual cusp on the buccal side and the buccal cusp on the lingual side. There were cases of that kind which most dental surgeons had met with.

Mr. Maxwell Stephens asked how it was that a canine would change place with a first premolar.

The President said the process was simple in the temporary dentition, but in the permanent dentition the tooth should follow its predecessor. There could be very marked displacement of teeth. He once removed a lateral incisor from the back of a palate, but it was associated with the dentigerous cyst associated with the central incisor. The whole of the tissues had been displaced by the development of the cyst. The rotation of a premolar could occur without difficulty. The tooth was not firmly attached before its complete development, and any slight force could rotate a tooth upon its axis. Mr. Pitts and he had an interesting case which they were going to show to the Society in connection with the growth of a sarcoma which had occurred in a boy. It had extended to the cheek and the arches had become flattened. The whole of the arch was pushed in both in the maxilla and the mandible, which showed how very plastic the tissues were. With regard to eruption of the canine, it was so high up in the arch that it was conceivable it could drop into a position behind another tooth that had moved forward. He believed the reason the permanent teeth did not go wrong very often was that the tissues were absorbed from above. With regard to one tooth relative to another, the directive force in the permanent series did not hold in the same manner as in the temporary teeth as the latter were frequently disturbed.

Mr. Lewin Payne, in proposing a vote of thanks to the President for his address, said those who knew Mr. Warwick James well were familiar with the careful and thoughtful way in which he dealt with problems which had baffled his predecessors, and the address he had given that evening was only another example of the magnificent work he was doing for the profession in elucidating difficult problems. He would not enter into any of the controversial questions which the address suggested, but confine himself to moving the vote of thanks.

The motion was carried unanimously.

The President briefly returned thanks.

Visit to the Société Francaise d'Orthopédie Dento-Faciale.

Mr. Harold Chapman made the following report :—

In response to an invitation from the Société Française d'Orthopédie Dento-Faciale to send a delegate to their meeting at Lyons on January 6th and 7th last, I was asked by our Council to attend. I travelled to France a day earlier so that I could attend the Orthodontic Clinic at the Ecole Dentaire de Paris, which is held on Thursday afternoons. No other work is undertaken during that time, the whole place being given over to orthodontics. The number of patients attending averages about one hundred. The department is in charge of Dr. Georges Villain, who attends and superintends all the work. Under him there are six instructors, each of whom has fifteen patients; each patient is attended by two dressers, a fourth year and fifth year dresser, and when the latter leaves the fourth year dresser goes into his place and another junior comes into the place of the fourth year student. That, I think, would probably solve some of the difficulties which we have experienced in this work. The treatment of one case by each student is compulsory, but they may treat as many as half a dozen if they wish to do so. Of course there being one demonstrator having only fifteen patients to look after enables the work to be done very satisfactorily. I must say that I found the molar anchor bands were extremely well put on. One of the demonstrators in charge was a lady. I do not think any of them are paid a

salary for the work. The apparatus which is chiefly used is of the Angle type, made of German silver—clamp bands, arches and wire ligatures, although Dr. de Nevreze, one of the demonstrators, uses the lingual arch with double vertical tubes. He tells me that the fitting of the arch with these tubes is not as difficult as it might at first appear, his idea being that the bands should be already made with the tubes in position before they are placed on the teeth at all. The arch also should be ready-made to certain medium patterns. It is not placed close against the necks of the teeth, but stands some distance away and auxiliary springs or other attachments are added to the base wire so that that part of the work is made very simple. He also uses the trans-palatine arch, of which I have a specimen here, with finger springs added to it. Another interesting point was that the models have to be made in duplicate; there are two sets for every patient, one for the student and one for deposition in the school so that if the originals are lost there are others to fall back upon. They are nicely cut up and articulate with one another in plaster.

With regard to the patients themselves, they certainly belong to the better class hospital patient. Their ages vary from 8 or 9 to 16 or 17. There was no tendency to keep the age of the patients low, and there was not the slightest tendency to limit the treatment to cases which were simple. I saw as bad cases of Class II, Division 1, there as I hope I shall ever see, and was amazed that treatment for them was undertaken so freely. Dr. Villain does not hesitate to advocate the distal movement of the first upper molars if he thinks that is the proper treatment and in estimating what movement he should make on those teeth he bases his decision on the facial angle. I did not see any case where extractions had been done.

With regard to the making of the plain molar bands, Dr. de Nevreze takes a band much deeper than necessary and fits it to the teeth. Then he marks the inside of the band with a probe or something of that sort, giving the outline of occlusal surface of the tooth; then he cuts away the band where it will come against the high portions or cusps of the tooth, but leaves a small portion which will correspond to the grooves between the cusps and this is later burnished into the grooves so as to prevent any slipping down of the band.

Undoubtedly the department is well organised and is going to be improved by the use of a special chart on which most of the data that is required will be already printed and it will be only necessary to delete what is not applicable. It is also the intention to cut the models so that they will show the relationship of the teeth to the face, as represented by the plane of Camper, the distance from the lower incisors to the chin and the direction of this line, etc. In one of the papers read at the meeting the method of doing this was to some extent shown, and I will say a word about that later. Dr. Villain tells me that he is hoping to arrange for several teachers from one of the American Universities to come to France to give instruction at the Ecole Dentaire, so that students who are willing to take the course will have definite teaching as given in America and be able to take examinations, and probably obtain the degree of that particular University if they acquit themselves satisfactorily. He has thought out this scheme, of course, because of the great expense incurred by French dentists in going to America at the present time.

With regard to the meeting at Lyons of the Société Française d'Orthopédie Dento-Faciale, there was a representative attendance of French dentists from various parts of France. This society has only one meeting a year; it occupies two whole days. Most of the dentists came from Lyons and Paris, and the average attendance was about forty or fifty. In addition to myself from England there was one dentist from Belgium and two from Switzerland.

The meetings were held in the Lyons Dental School. They were opened by an address from Dr. Pont, who welcomed the Society to Lyons and referred to the position of orthodontics in France. Last year Dr. Pont was to have read a paper in Paris, but illness prevented

his attendance at that meeting. He has completely recovered. It was a curious coincidence that he should give the opening address in the place of Dr. Frey, who was prevented from attending owing to illness.

The first paper was one on specialisation in orthodontics; it discussed the subject from points of views known here. In the discussion it was mentioned that, although specialisation might be desirable, it was impossible that all patients could be sent to specialists, and it was therefore of the greatest importance that all dentists should have definite and correct ideas about orthodontics so that they could overlook the treatment undertaken by specialists. The paper was read by M. Julien Tellier.

The next paper was by Dr. Izard on the Measurement of the Angle of the Jaw. He referred to the methods which had been adopted on skulls by means of a hinged board laid against the angle of the jaw, a scale passing through the raised piece whereby the angle could be read off. That was valueless in the living subject. Dr. Herpin had used a strip of lead, about ½ in. wide and 3 or 4 millimetres thick. Dr. Izard brought with him an instrument, two flat pieces of metal hinged and a scale on the part away from the mandible which measured the angle, but, as Dr. Villain pointed out, it was extremely difficult to lay one part along the posterior border of the ramus accurately, and he advocated placing projections (one of which was movable) on the part of the instrument which could be placed in the position required and probably measure rather better than with a continuous line. The various facial angles enter into French orthodontics very much more than they do into the subject in this country. Dr. Pont gave the following classification of malocclusion. He divided the causes into the hereditary and acquired, and the acquired ones were again divided into general and local.

PONT'S CLASSIFICATION.

1. Hereditary Causes
   - Properly so called I, II, III, IV
     - I Prognathism
     - II Retrognathism
     - III Bi-protrusion
     - IV Bi-maxillary atresia
   - Pathological
     - Syphilis
     - Tuberculosis
     - Alveolism
     - Injury at Birth
2. Acquired Causes
   - General
     - Rickets
     - Errors of nutrition and secretion
     - Syphilis
     - Measles, scarlet fever, etc.
   - Local
     - Hypertrophy of the frænum
     - Bad habits
     - Nasal insufficiency
     - Fractures and articular affection
     - Cicatrices
     - Nervous affections

Dr. Dreyfus, of Lausanne, showed a method for cutting models so as to exhibit certain relations between the teeth and face. He does not attempt to obtain the distance from the lower lip to the chin that Villain wishes to record by means of a particular way of trimming the models, but the top of the upper model corresponds to the plane of Frankfort, the centre vertical line to the plane of Dreyfus, and the vertical line in the canine region to the plane of Simon. Dr. Dreyfus exhibited a lathe to which was attached a circular saw for model trimming. Then Dr. Mouriquaud gave a long discourse on the effect of lack of vitamines, referring especially to beri-beri, pellagra, rickets, and scurvy. Dr. Quintaro described a method of fitting bands, the chief point being that where it was difficult to burnish the band to fit

a pronounced contour of the tooth, he made a cut in the band in this position, overlapped the edges, burnished them to fit the tooth and soldered them together again.

Dr. Villain read a paper on the treatment of Class II cases and reviewed their treatment, concluding by showing a method which he is using now very similar to that shown by our President except that when he opens the bite he covers the occlusal surfaces of the teeth with vulcanite in such a way that the lower molars occlude perfectly when the bite plane has caused the mandible to move forward until the molars are in their correct position. When the patients are accustomed to them after two or three weeks he cuts the vulcanite away from the molars and the inclined plane of the vulcanite in front keeps the mandible in its forward position.

There was a very enjoyable dinner given, and I wish to express my appreciation of the hospitable and kind manner in which I was received.

The PRESIDENT said the Society was indebted to Mr. Chapman for his report, and thought that what he had to say about the school was the most interesting part.

Mr. BULL asked whether Mr. Chapman considered that having two dressers to each patient rather tended to throw all the work on to the studious dresser, while the second dresser might ignore his duties.

Mr. CHAPMAN said he gathered that the senior man would do the majority of the work and the junior would look on, but the junior would ultimately become the senior and do the bulk of the work.

Sir HARRY BALDWIN asked whether Mr. Chapman had formed any opinion as to whether in France dental irregularities were about the same as in this country—whether the irregularities were the same in type, degree and percentage of the population. When he was in France, judging from the soldiers, he came to the conclusion that the teeth, on the whole, were much more regular in the French than in the English people.

Mr. CHAPMAN said he could not speak for the population generally, but with regard to the cases in the hospital, they were very similar to those in this country. The Class II cases were every bit as bad, if not worse than in this country.

The PRESIDENT said he had been interested to hear that Dr. Georges Villain was adopting the method of opening the bite. He was convinced it was a valuable method and was glad to hear it was used by so able a man. Dr. Villain was going to give the Society a paper in May. In conclusion the President hoped that the Society would devote an evening to short papers by junior members. It was felt by the Council and by members that the younger men took no part in the discussions on any subject, and it was considered that one evening might be devoted to giving the younger men ten minutes for the purpose of papers or making statements to the Society, and one or two had already indicated that they would be pleased to do that. He might almost describe the junior man as " the man who had never made any communication to the Society."

AN Ordinary Meeting of the Society was held at 11, Chandos Street, W., on Monday, February 5th, 1923, Mr. W. WARWICK JAMES, President, in the Chair.

The minutes of the previous meeting were read and confirmed.

The following candidates for membership were unanimously elected: W. A. Bulleid, L.D.S.Eng.; L. Edmund Claremont, M.R.C.S.Eng., L.R.C.P.Lond.; Thomas Stordy, L.D.S.Eng., M.R.C.S.Eng., L.R.C.P.Lond.

CASUAL COMMUNICATION by V. FITZGERALD SARGENT.

" A TREATED CASE OF CLASS III."

I FIRST saw this child when she was nine and the first slide shows the state of things at that time. Owing to the child going abroad I was

unable to start any treatment. The next time I saw the child she was eleven years and five months old and nothing had been done. The upper teeth were right inside the lowers. The second model shows the state of the case then and you will see that the upper teeth are absolutely locked inside. I put in a vulcanite plate, capping the molars and pegging out the centrals and laterals. That was done in the country in June, because the child was not remaining in London. Last year I saw the child again, on July 12th. I have no models showing when the teeth were pegged out, but it was practically edge to edge. I inserted a ribbon arch and tried intermaxillary traction. I saw her again on September 27th, and the next model shows that the teeth are well open. You will notice that the left canine is not fully down. At that date, September 27th, I removed the arches and the fourth model shows the case without any further treatment on January 2nd of this year. I think without further treatment the case will become all right.

The PRESIDENT congratulated Mr. Sargent on his successful result. Apparently the space was mainly gained by elongating the arches from before backwards, and it would be interesting to know how far expansion of the arches laterally might be of further value.

Mr. EDWARD D. D. DAVIS then read his paper :—

THE CAUSES AND EFFECTS OF MOUTH BREATHING.

THE effects of mouth breathing develop so slowly and so insidiously that this cause of poor physique, in spite of its frequent occurrence, does not appear to have received the attention it deserves. Nevertheless mouth breathing has contributed very largely to the formation of the round shoulders, flat chests, deformed jaws with bad teeth, and is accompanied by nasal obstruction with its attendant catarrh which contributes to the defective physique so commonly seen in many rejected army recruits or recruits of low category. If baby shows were extended to adults it is certain that no inveterate mouth breather would be judged worthy of a prize for physical development and perfect health or beauty. The presence of signs of mouth breathing will also help to decide the necessity for operation in doubtful cases of nasal septum deformity or for the removal of tonsils and adenoids.

The cause of persistent mouth breathing is not by any means confined to the obvious one of nasal obstruction. Nasal obstruction in young subjects is rarely complete but is more commonly intermittent and partial. For example, an adenoid growth in a child does not produce obstruction during the day when in the erect posture, and it is only at night during sleep that stenosis, rather than complete obstruction occurs. Similarly, deformity and deviation of the nasal septum produces a partial and sometimes intermittent obstruction according to the condition of the mucosa of the inferior turbinated bones. In a warm, moist, or vitiated atmosphere the inferior turbinals become relaxed and engorged to diminish the amount of air passing through the nose ; in a cold, brisk atmosphere the turbinals contract and nasal respiration becomes free and complete. In the mouth breather, this function of the nose is in abeyance and a vicious circle is established in which the turbinals become permanently engorged and lose their power of contraction and eventually become hypertrophied producing chronic nasal obstruction and an unhealthy state of the nasal mucosa. This variation of the nasal mucosa often makes nasal obstruction intermittent, and such a patient may have a free nose at the time of examination, and the cause of the mouth

breathing is not then evident, but the history of the patient will reveal symptoms of nasal obstruction particularly at night.

Habit is the commonest cause of mouth breathing and is difficult to cure even when the nasal obstruction has been eliminated. Confirmed mouth breathers are frequently seen who have perfectly free and patent noses in which there has never been any nasal obstruction; for example, the imbecile, with his open mouth but, strange to say, well developed jaws and broad free nose. In others, though the cause of the nasal obstruction has been removed by operation some years previously, they still remain mouth breathers. Again, there are some cases of mouth breathing in which there is a short upper lip and an open bite in which there is no nasal obstruction, but in repose the mouth remains open and can only be kept closed by a distinct effort on the part of the patient. Mouth breathing is thus sometimes due to an open bite and will persist until the open bite has been corrected.

Occasionally infants are seen who cannot suckle without difficulty and without frequent pauses to breathe through the open mouth, and if there is no other reason for this apparent nasal obstruction the pharyngeal tonsil, or so-called adenoids, has been scraped. For my own part, I am not quite sure that this is the real cause of such inability to suckle and it is feasible to suppose that these infants may have the same difficulty in carrying out this co-ordination of muscular action that older children have in blowing the nose. Moreover if the adenoid tissue is hypertrophied it is probably a temporary enlargement such as is known to occur during the first dentition. An infant who is allowed to lie and sleep on its back and is not placed in the correct position on its side, develops the habit of mouth breathing because, when relaxed, the lower jaw tends to drop by its own weight. It is probable that early and persistent nasal obstruction results in a want of development of the width of the floor of the nose, the antra, and maxilla, hence the difficult case with the pinched, narrow nose with sucking in of the *alae nasi* and poorly developed maxilla. It may be of value to know what is the normal width of the nasal fossa at certain ages compared with that of the maxilla. Such measurements can be taken by callipers, and in cases in which expansion of the maxilla is being carried out any increase in the width of the nose can be estimated. The development of the nose and jaws is closely associated and probably inter-dependent, but it is not so certain as to which is the primary cause of the irregularity in spite of the fact that clinical evidence frequently condemns the nose. Looking at this skull which has particularly well developed normal jaws and nose the orthodontist would say "what a free, broad nose; no wonder he has good jaws," but the laryngologist would reverse it and remark "what a good well developed maxilla; no wonder he has a good nose."

Deformities and irregularity of the shape of the jaws and position of the teeth are due to a combination of causes of which nasal obstruction is undoubtedly a contributary and active factor and certainly increases any existing deformity. It is generally accepted that the muscular action of the tongue, cheeks and lips have a direct influence on the moulding of the jaws and this action is disturbed in mouth breathers; also it is admitted that orthodontic treatment of deformities associated with nasal obstruction fails, owing to relapse, unless nasal breathing is established.

The shape and size of the jaws and position of the teeth is often hereditary and racial. For this reason, there are several types of normal jaws which are in conformity with the contour of the head and face, and typical of the race or nationality of the subject. The inferior protrusion on the undershot jaw, though increased by a defective occlusion, the absence of lateral incisors, and the diastema between the central incisors, are inherited. The long narrow jaw of the Gold Coast negro and the square, rounded jaw of the European are racial. There have been slight differences of opinion as to what is the type of normal jaws, but for practical purposes and from my own observations, I would define those jaws as normal in which the arches are round and symmetrical with the teeth in line and almost an edge to edge bite, with slight overlapping of the upper incisors. I have seen many patients who are undoubted mouth breathers but have no deformities of the jaws, and I have records of several cases of neglected adenoids with septum deformity and nasal obstruction where the jaws are well developed and normal. Conversely, deformities have been present in patients who have perfectly free noses, are not mouth breathers, and have no flattening of the chest; and in others who have had tonsils and adenoids efficiently removed before the age of 6. (Illustrated by models.) I have the records of a patient with atrophic rhinitis which commenced in childhood and who has superior protrusion and an open bite similar to that seen in cases of nasal obstruction. J. G. Turner reports that children who have worn tracheotomy tubes for prolonged periods do not show any abnormality of the jaw. It is also remarkable that in the few recorded cases of congenital occlusion of the posterior nares, which is nearly always unilateral, there were none of the deformities usually associated with mouth breathing and nasal obstruction. From the above facts it can be claimed that nasal obstruction does not produce a simple and direct mechanical action on the mouth, but I think that all will admit that it plays a contributary part.

The type of deformity associated with mouth breathing becomes definite about the age of 6, but the want of development can be recognised even at an earlier age by the absence of the spacing of the temporary teeth with little room for the eruption of the permanent teeth and this is followed when the first molars are erupted by a post normal occlusion leading to the absence of edge to edge attrition of the incisors. Finally the deformity of the jaws seen at a later age is the narrow maxilla with lateral compression and the resulting high palate and superior protrusion forming what is known as the V-shaped jaw or gothic arch. It may be accompanied by the open bite as the result of the compression lowering the alveolus of the upper molar and bicuspid region, or possibly by the protrusion of the tongue between the teeth. The mandible sometimes shows depression of the molars exaggerated by the elevation of the incisors of the mandible which may occlude with the palate instead of the maxillary teeth. (Illustrated by photographs and models.)

Open bite not only prevents efficient mastication, but the want of use of the incisor teeth increases the marginal gingivitis already present as the result of mouth breathing and hence probably arises early pyorrhœa alveolaris. In emphasis I would repeat that this type of patient will always be a mouth breather until the open bite is corrected.

My clinical experience coincides with M. H. Cryer, who found that the high palate is not always associated with a congenital nasal septum deviation and, conversely, a congenital septum deviation is frequently seen in patients in which the palate is flat and well rounded. The maxilla, as you know, forms the greater part of the nose and particularly the floor of the nose which is most concerned with respiration, and I am sure that deformity and cramping of the maxilla produces a narrow, obstructed nose and it is here that the orthodontist can help the rhinologist by developing the maxilla, and one looks forward to greater co-operation and team work between the orthodontist and rhinologist in this respect.

The mouth breather of long duration possesses the thin, narrow, poorly-developed nose with the sucking in of the *alae nasi*, and it is in this type of case that the results are so well shown by the early morning dry mouth and headache, the want of tone and clearness of speech with its disadvantage to the singer, also the susceptibility to catarrhal and middle ear deafness, the congestion of the fauces and pharynx, sore throats, laryngitis, and the obvious detrimental effects on the chest. This type of patient is susceptible to catarrhal attacks and suffers from frequent and prolonged colds with the inevitable loss of time and work due to sickness. The effect on the development of the chest is most important. The deformity is well illustrated by this photograph lent by Sir St. Clair Thomson. The round shoulders, the flat, shallow chest and depressed infraclavicular regions and the winging of the scapulæ are characteristic. This deformity is increased in rickets, but it can be distinguished from the pigeon breast, the Harrison's sulci below the mammæ accentuated by the eversion of the costal margins and the funnel-shaped chest which are due to the pull of the diaphragm on the soft ribs, and even these rickety deformities are considered to be increased by mouth breathing. This deformity of the chest, with its shallow breathing and want of expansion with frequent catarrhal attacks, is undoubtedly a predisposing cause to pulmonary tuberculosis and bronchitis, and the effect on the general health is obvious, but the mechanical reasons for such deformity of the chest produced by mouth breathing are not so easy to explain, and it is to be noted that in cases of laryngeal obstruction due to a congenital web of the larynx, congenital stridor, papillomata, etc., there is no deformity of the chest.

It is difficult to estimate how much mouth breathing and nasal obstruction affect the mental development, but the open mouth with flat chest and thrusting forward of the face with the occasional hardness of hearing always gives the impression of a want of intelligence and alertness, and is well illustrated by this photograph of a group of footballers showing the physique of a well-marked mouth breather.

The treatment of mouth breathing is carried out on the following lines :—

(i) Nasal obstruction, if present, should be corrected as early in life as possible. Nasal obstruction should not only be detected by the tests such as holding a feather or flake of cotton wool in front of the nostrils, but by the presence of mouth breathing during exercises.

(ii) Breathing exercises to promote nasal breathing and to expand the chest.

iii) Early correction of open bite and superior protrusion, with appliances to correct the habit of mouth breathing and snoring. (I know of no better or more successful appliance than the mouth screen devised by Mr. Warwick James.)

(iv) The late case with the thin, narrow nose with *ala* collapse is a most difficult type to improve or cure, and a forlorn attempt to increase the width of the nasal cavity by a dental appliance which expands the maxilla and opens the intermaxillary suture has been attempted.

In conclusion, the modern orthodontist if given an early opportunity can mould and train the growth of the jaws like a gardener trains a tree. He is also in a position to detect mouth breathers at an early age and, in co-operation with the rhinologist and drill sergeant, he is able to render a great service by improving the physique of the nation.

REFERENCES.

Diseases of the Nose. Lambert Lack.

The Relation of Nasal Obstruction to Dental Disease by J. G. Turner. Transactions Section of Stomatology, 17th International Congress of Medicine.

The Supervision of the Health of Children between Infancy and School Age, by W. Warwick James. 17th International Congress of Medicine.

Discussion.

The President said the Society was very much indebted to Mr. Davis for his Paper which was of very great interest and contained much food for thought. There must be many members present who held views upon mouth breathing, which was almost the basis of orthodontics in many respects. He should like to ask the author what he regarded as the earliest age at which mouth breathing occurred. It had been said that adenoids occurred in a pre-natal condition, as had been found in hospital practice, and it would be interesting to know at what age the greater number of patients usually developed obstruction. The author had said that habit was the commonest cause; if that was so he placed the breathing through the mouth before the obstruction of the nose. In discussions which had taken place between those practising dentistry and rhinologists the matter was argued by one party in one way and by the other in the reverse way. He thought the majority of people up to recent times would have said that nasal obstruction was the primary factor. He himself thought that mouth breathing might precede the obstruction of the nose. The term mouth breathing was one which was used rather indefinitely. If the lips were apart, although the mouth was not actually used for the passage of air, the patient would still be called a mouth breather because it presented the deformities which occurred by the action of the cheeks and the absence of the action of the tongue. Such patients might be almost called patients with lips apart. There were cases which showed almost complete nasal obstruction and the mouth must necessarily be used for respiration, but the majority of cases, he believed, would be classed as partial obstruction of the nose. There were cases where the lips were kept apart where the nose was quite free, and he should like to know in what proportion those cases could be grouped.

Mr. W. J. May referred to enlarged glands that sometimes occurred in the neck of children when there was no apparent cause and no septic teeth, and as far as could be seen the throat was free from obstruction and the tonsils normal, but the children still had enlarged glands, and he should like to ask the author's opinion as to the exact significance of those glands, and also whether he had any statistics to show what proportion of the glands were tubercular. He had read that of tonsils

removed, some three or four per cent. were found to be tubercular. How many glands, even the smaller ones, were found to be tubercular ?

Mr. A. T. Pitts said the subject was one of tremendous interest and perhaps of more importance than anything else to the orthodontist. He was glad the author had laid emphasis on the fact that the relationship between mouth breathing and deformities of the jaw was not such a simple one as was often suggested. Very often dentists made the relationship much too simple, assuming that as the floor of the nose was the roof of the mouth, the two were connected and varied directly. It always seemed to him that there must be some other additional factors because at different times nearly all the deformities of the jaws were said to be due to mouth breathing. Cases of post-normal occlusion or excessive overbite were said to be due to mouth breathing but the author suggested there might be some other factors and it seemed to him also that there might be certain other factors which co-operating with the mouth breathing would show why, in some cases of mouth breathing, there was marked deformity and in others not. Mr. A. J. Wright, of Bristol, recently reported a case of two sisters with bony occlusion of the posterior choanæ and they had had mouth breathing from birth. He said that the jaws were quite well formed and went on to suggest that possibly partial obstruction might be a greater factor than complete obstruction. Where there was mouth breathing due to enlarged tonsils and adenoids there might be pathological factors coming in, whereas in cases of occlusion of the choanæ, the element of infection might be absent. Lawson Dick, in his most interesting book on rickets, attributed a very large number of defects of the jaws to that condition. He thought that rickets, in conjunction with nasal obstruction, which might lead up to adenoid vegetations, had a profound influence in modifying the shape of the jaws. Those changes in the jaws which Sir Arthur Keith had suggested were due to an evolutionary factor, were, according to Dick, much more likely to be due to rickets which he regarded as the cause behind the nasal obstruction accounting for deformities of the jaws. With regard to the point made by the author as to the effect of mouth breathing showing itself by absence of spacing of the incisor teeth, it was interesting to know that Wood Jones in his book on "Arboreal Man," referred to that subject and considered that the absence of spacing, which was very often met with, might be an evolutionary factor due to the progressive diminution of the jaws owing to their lack of functional vigour as compared with more primitive types. With regard to inheritance of the conditions associated with mouth breathing, he knew of a case of a father and two sons who both had superior protrusion with post-normal occlusion, with narrow noses. Was that due to an environmental condition, or was there in such a case a true inheritance, and if there was a true inheritance was there any possibility of trying to effect any improvement by orthodontic treatment ? With regard to the age at which the cases came in, he had had one child of about three years of age, with extremely marked superior protrusion and post-normal occlusion, and he was inclined to think of mouth breathing as a cause. That was the earliest case he had seen. Mouth breathing under some conditions was physiological. In violent exercise the mouth was kept open. Especially was that the case in running, and dogs like the greyhound breathed through their mouths at that time. It would not seem that mouth breathing always brought with it the long trail of disabilities attributed to it. Some time ago there was an article in the *Lancet* on the condition of the mouth in airmen and the statement was made that some of the airmen were mouth breathers and did not appear to suffer in any way from ill effects. Had they been examined by a dentist some results of mouth breathing might have been detected. With reference to the definite effects of gingivitis, there was one point which Mr. James and himself brought up in a paper some time ago, namely, denudation as a factor in eruption and it was thought then that undoubtedly in mouth breathers the denudation

of the incisor teeth might be incomplete and that therefore that might be a predisposing factor to pyorrhœa later on. With regard to treatment he was glad that the author had spoken of the oral screen, because although that was familiar to most dentists it did not seem familiar to medical men. Most of the rhinologists he had spoken to had never heard of it; yet he was convinced that it should be a most important ancillary treatment of the conditions and rhinologists would find it very useful. The very earliest case he had had was a little child of three years of age who had mouth breathing, but not nasal obstruction, because the adenoids had been removed. The child used to get a discharge of blood from one nostril at night. With considerable difficulty he took impressions and made a mouth screen of aluminium, and after some trouble he got it into place and told the mother what to do. A fortnight after the child was brought to him in the out-patient department peacefully sleeping with the instrument in place and he was told that the discharge of blood had stopped at night. He thought that where it was considered that the instrument should be used in connection with a mouth breathing habit, before doing so the child should be examined by a rhinologist to see the condition of the nasal mucosa and to judge of the effect, if any, induced by a cessation of mouth breathing. In cases where mouth breathing existed it would be extremely interesting to be able to estimate the condition and then see later what changes, if any, were induced by a return to nasal respiration at night. Neurologists were very fond of quoting a high palate as a stigma of degeneracy. He had often been puzzled by that and had tried to track it down to its source, without any success. Neurologists did not seem to be able to say how it came about. There were many cases of high palate, and he found it very difficult to imagine a high palate could be considered as a sign of degeneracy. It seemed to him that the best explanation might be that in such cases a high palate might be associated with adenoids, when the children were deaf and cut off from the stimulation which children with normal hearing had, and therefore became stupid and that became stereotyped into definite mental defect, and for that reason the palate was put down as being one of the stigmata. He did not think there was any causal relationship. It seemed to him that if the neurologist would consult the dentist better information might be obtained on that point.

The PRESIDENT, referring to the question of habit, said at one time he collected a large number of cases where thumb sucking and habits of that kind were common in very early life, and he had frequently thought that that might be a factor in the production of mouth breathing. There must be some factor of that sort if mouth breathing be the primary factor and not nasal obstruction. It might be merely habit. He had also wondered whether children who had too many bed clothes adopted the habit. A child with a high temperature would frequently open its mouth to breathe and there seemed to be some effort at respiration. In his own children he noticed that if they became hot at night, and had too many bed clothes, they turned on to their backs and lay with the mouth open. The loss of heat which occurred in animals might apply to human beings; they might like to get additional moisture through the mouth instead of up the nose.

Mr. W. RUSHTON said that years ago orthodontists used to think they knew something about the cause of mouth breathing, but they were getting more and more puzzled and the subject became more enigmatical and complex as time went on. Formerly it was said: "If you close your mouth you will find the tongue absolutely fills the oral cavity; therefore you have the muscles on the outside more or less exercising their influence, counteracted by the muscle of the tongue on the inside, and if these two are in equilibrium you have a properly moulded arch." It seemed to him a most rational thing to believe, but the author and others say that there are many cases in which we do not get contracted arches supposed to belong to the typical mouth breather. When the mouth is kept open the tongue naturally drops to the floor of the mouth. The muscle of the tongue therefore exercises

no countervailing force in the upper jaw, but it does in the lower jaw. In one of the photographs that had been shown there was a very narrow vaulted maxilla and a very finely developed mandible, which seems to bear out the theory. The theory was so absolutely reasonable, that one was rather disinclined to throw it aside without finding something else to take its place and he should like to ask the author whether he had an equally satisfactory theory to bring forward. Mr. Pitts had mentioned the case of a child of three in which he saw very marked superior protrusion, and the President had mentioned that there were many cases of thumb sucking. It seemed to him that many cases of thumb sucking simulated mouth breathing, but thumb sucking and mouth breathing were mutually antagonistic because it was not possible to suck the thumb and breathe through the mouth at the same time, or at least with any pleasure. With regard to the age at which adenoids came, he had seen a young mother that very morning, who told him that her newly-born baby had to be operated on for adenoids because the doctor said the child was born with adenoid obstruction and that the sooner the operation were performed the better. He was wondering if that were true. He wondered if nature so far forgot herself as to start a human being in the wrong way like that. One thing quite certain was that, as so-called civilisation advanced, the shape of the face and the shape of the jaws were very profoundly modified. Once upon a time he had great interest in going through the pictures of many of the old Royal houses, particularly the Hapsburgs and the Medici. Both those families started all right with well-developed heads and jaws, but as centuries passed by, the type of head and face entirely changed and some of the later representatives of those houses, instead of having fine broad, well-developed features, had narrow, long, typical adenoid mouth-breathing faces. Typical instances could be seen in portraits of our King Charles II and King James II who were descended from the house of Medici, and he should say that, in that house and in the house of Hapsburg after a time, the predisposition to that condition became hereditary. That could be seen in the portrait of the present King of Spain, whose children he believed had been under treatment for that same sort of thing. The author considered that habit was the commonest cause of mouth breathing, and the question arose what was habit ? He would define it as something which tended to proceed on the line of most comfort or least resistance. Nature, he thought, intended man to breath through the nose and that was a natural habit. If for any reason there was any discomfort in that habit, another habit was taken on because that was the line of least resistance. He thought Mr. Davis must find some other reason. In conclusion, he thought it an excellent thing when a gentleman who had taken the L.D.S. had gone into another branch so closely allied with dentistry. It was in the mutual interchange of thoughts on such subjects that something would be finally reached in the way of an increase of knowledge.

Mr. Pitts said he had excluded thumb sucking in the case he mentioned.

Mr. J. W. Mayer said the author had mentioned that he had used the anti-mouth-breathing apparatus, and he himself had also used it, but did not seem to be very fortunate. Most of the people he had asked to wear it had had so much difficulty that they were inclined to give it up without taking any further trouble. One doctor had used it and had become weary with it. He himself had used the apparatus which was demonstrated by the President, a soft rubber apparatus, and he should like to know if the author found that he obtained universal satisfaction from the apparatus ?

The President said at times there was undoubtedly great difficulty in inducing people to wear it, and it depended a great deal on the age of the patient. If a person had been breathing through the mouth for a great number of years, it was a habit exceedingly difficult to break. It was only by persistence that the result could be achieved, and he did not think it could be achieved in all cases, but in a number of cases extraordinary results were obtained.

Mr. GEORGE THOMPSON asked whether there was any connection between deformities and breast feeding or bottle feeding. He thought the breast-fed child brought up in a healthy environment might suck its thumbs or do anything else, and the bones would not be influenced in any way.

Mr. H. CLARKE asked whether if a patient about the age of thirteen or fourteen came with nasal passages that had been well cleared, and without evidence of mouth breathing, but with an open bite and a very narrow upper arch and a fair lower arch, with considerable spaces between the teeth, and by orthodontic treatment the appearance of the deformity could be corrected, the patient would benefit to any marked extent; was there going to be very considerable improvement in the health, or was there very little to be hoped for with regard to general physical condition?

Mr. PACKHAM said several wearers had told him that their night's rest would be disturbed without the use of the mouth valve, and that seemed curious. One patient of his asserted that he could cure an on-coming cold by wearing the mouth valve for two or three nights. With regard to classification of mouth breathers, some mouth breathers were really mouth breathers, and others, although they had the lips apart, were not mouth breathers at all. The question was a very important one, and he agreed with the author that the correction of the open bite was one of the most important factors in correcting the habit of mouth breathing. If it was impossible for the lips to be closed, as was very often the case with children where the lower lip was inside the upper incisors, he took it that until either the lower jaw was advanced or the upper incisors retracted, the two lips could not meet and the mouth breathing would not be stopped.

Mr. S. WILSON CHARLES said he agreed with Mr. Rushton that thumb sucking and mouth breathing never went together. He had a baby at the present time who sucked her thumb, and as soon as she went to sleep, took the thumb out of the mouth. He had tested her every night for the last week and she breathed through the nose. When she started a cold she breathed through the mouth. Another child invariably breathed through her nose when she was sucking her thumb, and at other times breathed through her mouth; as soon as she took her thumb out she breathed through her mouth.

Mr. RUSHTON said that with regard to a child whose lower lip was always behind the upper teeth the same rule applied; children could not breathe through the mouth and keep their lips in that position.

Mr. W. KELSEY FRY said it would be interesting to know the easiest way to get rid of the open bite, whether it could be done by exercising the lips. He had had a little experience in plastic work and had found that by exercise the lips could be stretched enormously, and he was wondering whether a little exercise would be of value in orthodontics.

The PRESIDENT said he had quite a large experience of thumb sucking and other forms of sucking, and believed the deformity that was produced defeated the very point Mr. Rushton had made that the tongue and the lips occupied the space. There was an actual space created between the incisors. It did not occur in all thumb suckers, but if they apparently bit with a repeated action of the mandible the deformity was greater. If the jaws lay passively in position it apparently did not produce a deformity. He had found definite thumb sucking with no deformity and he had come to the conclusion that it was a muscular action which produced the deformity and the space created between the incisors permitted air to enter both through the mouth and the nose and in due course the mouth breathing habit could be created. If a child closed its lips where deformity had been produced, the lower lips came under the incisors and acted as a cushion, increasing the deformity, and mouth breathing was probable.

Mr. RUSHTON asked whether sufficient air could be got between the teeth to satisfy the lungs?

The PRESIDENT did not think it was necessarily so, but some air passed through the mouth and some through the nose, and it was only necessary to establish nasal catarrh for mouth breathing to occur.

Mr. PITTS asked whether it was possible to breathe through the nose and mouth simultaneously.

The PRESIDENT thought it was certainly possible.

Mr. DAVIS, replying to the discussion, said he had not the same confidence that he had when he started. It was a very difficult subject and there had been many questions difficult to answer. The President had spoken about the earliest age in which mouth breathing occurred. Mouth breathers were brought with a diagnosis of adenoids, the mother bringing the child along to have its adenoids removed. Just before the war he collected notes of about 1,061 tonsil and adenoid cases that he had done, and he looked through them to see the number of children from whom he had removed adenoids under the age of two, and there were only four or five. The majority of children who had tonsils and adenoids removed were considerably over two years of age. Therefore he did not think that mouth breathing in children was really very common, yet Mr. Jones of Birmingham said he had removed adenoids in a large number of cases of infants who were unable to be suckled. Such cases were not seen by him. He had several colleagues at work at the Children's Hospital, and they said that they removed adenoids but that they did not know that it made very much difference. Even Lack would not admit that an adenoid growth was congenital. A child was born of course with a pharyngeal tonsil, which became hypertrophied, but he said children were not born with enlarged tonsils. It was difficult to say whether the mouth breathing started first or nasal obstruction, but he was rather inclined to think that nasal obstruction would bring on the other. With regard to Mr. W. J. May's remarks about glands in the neck, when one was unable to find a cause for enlarged glands in the neck, if there was no focus of sepsis one looked on them as tubercular. In the smaller glands it was difficult to prove they were tubercular because they were not removed. In some cases in which they had been removed they had been demonstrated to be tubercular. There was a difficulty in finding the tubercle bacillus actually in the tonsil. One might get a group of cases in which the glands in the angle of the jaw were tuberculous; it commenced in the tonsil and spread to the tonsillar gland and so on, and it had been proved at the children's hospitals that when those glands occurred in ninety per cent., the infection arose through the tonsil. It had been actually found that milk from cows had been a source of infection. Mitchell examined a number of cases at the Children's Hospital in Edinburgh, and found that ninety per cent. of that particular type of case arose from milk. Chronic sepsis would account for a certain amount of enlargement of the glands in the neck. Mr. Pitt's remarks had been very useful. With regard to high palate, Mr. J. G. Turner had examined a large number of asylum children and found that they had particularly well-developed jaws, and there were very few high palates, and he pooh-poohed the idea that high palates had anything to do with imbecility. He himself had been to that asylum and gone through the cases, and found very few children with high palates and he believed that idea must be given up. It was a thing that was copied from text-book to text-book. He thought mouth breathing had a good deal to do with temperature in connection with exercise. If the temperature of a man was taken just after he had played football it would be found to be 100° or more, and he believed the man took air through the mouth as a method of reducing the temperature, just as a dog did. He quite agreed with Mr. Rushton about the tongue. It seemed a most reasonable thing because the tongue was a very powerful muscle which had a very distinct moulding effect upon the jaws. He did not know any better argument than the position of the tongue in the mouth for the moulding of the jaws, but if one went into the question in connection with deformities one got into a tangle at once. Thumb sucking was a difficult problem and the President's explanation of

why in some cases there was a deformity arising from the sucking of the thumb and in others not was interesting. He thought it depended on muscular action. He was discussing the question of deformity and thumb sucking, after seeing a number of cases Mr. Colyer showed, with another nose and throat surgeon who lived in South Africa. That surgeon had beautiful jaws and he put his teeth together and said that he sucked his thumb for many years, and his family, numbering five, were all thumb suckers and had perfectly good jaws. With regard to the mouth screen, it did need a little perseverance. He had an aluminium mouth screen made for himself, but he found it rather hard and made him salivate and he eventually took it out of his mouth. He was going to try the rubber screen which was very much more comfortable and patients, especially the older ones, would wear it. It was difficult to train children at first, but if done gradually and with kindness it would be found that they would wear it. It could be put in the mouth for five or six minutes at a time, and that time increased until the patients fell asleep with the screen in position, and once that happened the difficulty was over. It was the best appliance he knew of to correct mouth breathing. Skull caps and chin straps and various other appliances, if they became loose, did not do their work properly ; they were pulled off or worked off during the night. He did not know of any better method to cure the habit of mouth breathing than the mouth screen. With regard to breast feeding, he could not answer the question satisfactorily, except to say that he looked upon a breast-fed child as a perfectly healthy and normal child. An artificially fed child became a little delicate in health. Also one looked upon a healthy child as more easy to control. Apart from that he did not know whether there was very much difference. With regard to patients of fourteen or fifteen years of age being amenable to treatment, he thought patients could be treated up to about twenty-one or twenty-five, until they were fully developed, but it was very much better to get them as early as possible. It was hopeless to try to expand the maxilla in a patient of twenty-one. Once a patient could be given a free nose and convinced that he could breathe through his nose quite freely, he was very persevering in wearing the mouth screen. That was probably the crux of the whole thing—to make them feel they had a perfectly free and good nose which they could use.

On the proposition of the PRESIDENT, Mr. Sargent and Mr. Davis were thanked for their communications, and the thanks of the Society were accorded to those who had taken part in the discussion.

The Meeting then adjourned.

AN Ordinary Meeting of the Society was held at 11, Chandos Street, Cavendish Square, W., on Monday, March 5th, 1923, Mr. W. WARWICK JAMES, President, occupying the chair.

The minutes of the previous meeting were read and confirmed.

Messrs. Alfred Jameson and Thomas Sordy signed the obligation book and were formally admitted to membership.

Mr. J. N. Strickland, of 55a, Welbeck Street, W.1, was unanimously elected a member of the Society.

Mr. W. H. DOLAMORE read a paper on

INFERIOR RETRUSION.

GRADUALLY, over the course of many years, it has been pressed upon me that superior protrusion, properly considered, is infrequent. It has seemed, as I watched these cases, that most which as a student I was taught to regard as superior protrusion, and about which much has been written, are not so at all, but are cases of inferior retrusion. Fig. 1 illustrates this.

It represents a case that came the other day for a denture. The patient said that, when a child, her upper front teeth had been

retracted. The lower incisors bite behind the upper ones, reaching almost on to the gum, but the lower premolars are in post-normal occlusion with the uppers. For aught I know to the contrary, the treatment by retraction of the upper front teeth may have been relatively successful and the facial effect of the present abnormal occlusion is masked by the patient having an unusually fat face. Nevertheless it would appear certain that, as years roll by, when the upper front teeth begin to elongate, these must be forced out into that prominent position which the worser sort of Continental comic papers present as caricatures of an elderly Englishwoman.

The lower front teeth biting upon the gum behind the upper teeth, force these in most cases to take up a position of undue proclivity. But I think this to be a secondary effect, and as having quite a distinct cause from those cases I regard as true superior protrusion. As a rule, however, it is this undue proclivity which is the arresting feature at a first glance. Often I have found that students diagnose the case as being this and this only, and the more readily because the under-developed condition of the child's nose is not remembered. Indeed, often parents when told of the essential fault are apt to demur to its correction on the ground that the mouth will be too prominent and the face disfigured.

Figs. 2 and 3 show the profiles of a mother and of her daughter. The latter is rather older than the age I am now considering, being 14 years of age. In this case of post-normal occlusion the upper front teeth are retracted, and the first step in treatment has been to push them further forward before attempting to bring the mandible forwards. I have, however, no doubt that in time the girl's nose will develop to equal somewhat the prominence of her mother's, and will cause the lower part of her face to appear more retruded than now, unless the post-normal occlusion be corrected.

Fig. 4 represents a boy of 4 years of age. The diminutive nose and retruded chin are well marked. This case raises a point I should like to see investigated, namely whether in all cases of post-normal occlusion of the permanent dentition this condition is present in, or foreshadowed by the deciduous dentition. My own impression, but it is not of great value, is that some cases at least do not develop till the change of the dentitions is in progress. If this doubt were definitely solved, one way or the other, light might be thrown on the etiology of the condition, concerning which I have nothing to offer.

Personally, I am at loss to explain the condition, and its cause seems to me to require investigation. One would like, in the first place, to know whether the mandible is, or is not, of normal size. For the purpose of discussion I assert that there is usually no diminution in its size, but I have no statistics to present to you. It would appear well worth while to have a very large number of measurements taken. But it would be necessary not only to establish an average standard size for the mandible, from which variations could be noted, but also, by some means, a proportional standard, to show its normal size relatively to the other facial and cranial bones. These measurements would give also the relative frequency of post-normal occlusion and show the age at which the defect begins to develop.

If the defect is not to be found in a variation of the size of the

mandible, is it due to a malformation, or variation, of the articular surfaces of the tempero-mandibular joint?

Fig. 5 shows tracings taken from the glenoid fossæ of a number of skulls. These were taken in 1901 to illustrate the paper which Sir Charles Tomes and I wrote concerning the movements of the mandible. Some of these were taken from bodies in the dissecting room, and the bone surfaces were therefore covered by cartilage, whilst others are from dried specimens in the College of Surgeons Museum. They show a wide variation in the shape of the fossa mandibularis, or more correctly of the development of the tuberculum articulare. Whilst the striking development of this in the "Howling Monkey" proves it to be a variation concomitant with the over-development of the hyoid bone and related to a thrusting forward of the mandible during its depression to allow this to avoid the prominence in the neck caused by the hyoid. The more erect the head is held in man the more necessary is this forward movement of the mandible during the opening movement in order that the neck structures may be cleared, and Lubusch states that the tuberculum articulare attains its greatest height in civilised races. This variation would here appear to be a concomitant variation, but this does not necessarily seem to exclude the need for observations to see whether or no some aberrant abnormality of form of the articular surfaces is a causal, or at least a contributory factor, in abnormalities in the position of the mandible. Moreover it is stated by Wallish that normally the condyle rests on the back of the tuberculum articulare and that normally there is no pressure on the floor of the fossa mandibularis. The actual position of the condyle in these cases is well worth ascertaining. From *à priori* reasoning it would seem clear that if Wallish's statement is correct then any cause, such as lack of relativity in the rates of growth of associated parts, might lead to the condyle occupying a more dorsal position, in other words to a posterior or dorsal displacement of the mandible. For we know that slight movement at the joint is associated with greater displacement of the body of the mandible, and I think it to be true that in all these cases the mandible does approximate the maxilla more closely than normal, since by raising the bite the appearance of the patient is improved. Such a dorsal movement of the condyle cannot, I think, take place unless the tempero-mandibular ligament is stretched and I have found that it is very rare indeed for a person to be able to retract the mandible beyond the normal, though of this I have seen a few instances; but the movement even then was very slight.

Some time ago I called attention to the fact that if a number of teeth in the maxilla and mandible be removed, then for some few days afterwards the upper and lower gums cannot be brought into contact, but that after a while they can be. Over-closure of the mouth is not possible unless the condyle can move dorsally beyond the normal, and this again is not possible unless the tempero-mandibular ligament is stretched. It must be assumed that the latter does stretch under the constant strain of the attempts to approximate the gums. This seems to be proved by the fact that if, after it has stretched, the patient wears artificial dentures, and hence the strain be removed, then the ligament will again contract and the gums can no longer be made to meet. It seems to me that it is on a similar contraction that we must rely, at any rate in the first instance, to help us in the treatment of these cases.

"INFERIOR RETRUSION."

By W. H. Dolamore, L.D.S., M.R.C.S., L.R.C.P.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

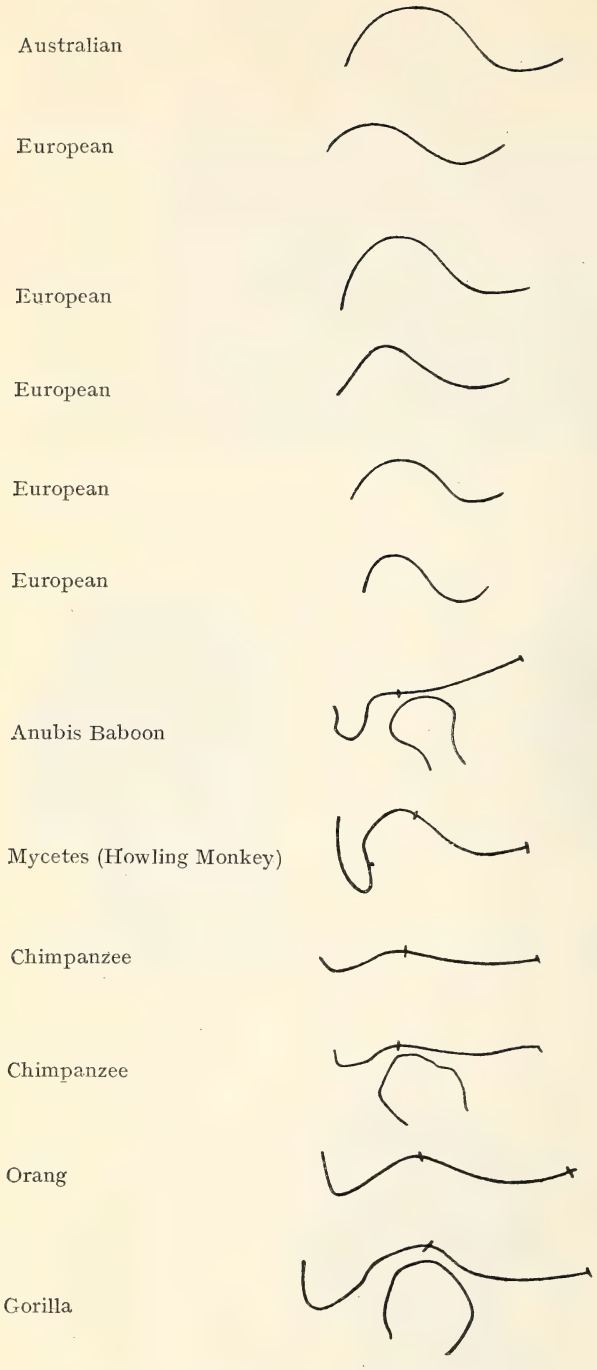


Fig. 5. A series of tracings of the glenoid fossæ and eminentia articularis of man and certain apes.

It is not necessary to describe the ordinary clinical features of these cases. The desideratum in treatment is to persuade the patient to bite forwards and to cause, or allow to develop, a condition which either will prevent the mandible moving backwards or will render the forward bite so much more comfortable that the patient will naturally and habitually place the mandible in this position. If this latter can be attained, then on the preceding reasoning it follows that the tempero-mandibular ligament will contract and that then the former dorsal movement of the condyle will be impossible. For all practical purposes nothing else is necessary though it may be assumed that in the course of time other structural changes may take place in the form of the articular surface.

Years ago I treated periodically a boy during his school years. The articulation of the upper and lower teeth was perfectly normal. In course of time he entered the Army and was stationed at a distance from London so that I ceased to see him, but upon a visit of his mother she told me that his jaw had become underhung. The question arising of what could be done to treat this deformity the patient did, upon a visit to London, call upon me. I found the condition to be as described to me. The mandible bit forwards, the lower incisors being in front of the uppers, the premolars and molars were in good working occlusion though in prenormal position. Mr. Matheson also described a similar case though I am unable now to give a reference to it. I am persuaded that the cause of the development of this condition was the over-eruption of the wisdom teeth. This eruption is frequently accompanied by tenderness of the overlying gum, due to the pocket the latter forms becoming filled with septic matter which, following a trauma during mastication, infects the tissues. This tenderness naturally induces the patient to bite in a forward position since this is the only way by which pressure on the gum can be avoided. I conceive, in these very rare cases, this forward bite becomes habitual and that, therefore, the wisdom teeth do not come into occlusion until they have over-erupted. In other words, when the tenderness of the gums has passed, or more correctly when the gum over the teeth has been absorbed, the forward bite ceases to be one of convenience but, because of the over-eruption of these teeth, becomes a mechanical necessity if the other teeth are to be brought into occlusion. I am myself convinced that neither in this case nor in the cases about to be described, have the teeth moved bodily forwards in the mandible as has been suggested.

Following this reasoning the treatment I have tried is to obtain over-eruption of the second molar teeth. It is I think essential to distinguish between what, for lack of a better nomenclature, I venture to call physiological and pathological over-eruption. The case just described was a physiological over-eruption. The ordinary physiological forces, be they what they may, were at work. Within limits, a tooth erupts until it meets its fellow and then the alveolar bone develops around it and fixes it in this position. If this takes place we know the tooth will resist the force of mastication—for if it were not so the first molars would upon early loss of the deciduous molars be bitten back into the bone. This physiological elongation differs from the pathological, since the latter depends essentially upon the thickening of the alveolar periosteum, or upon the contraction of the alveolar dental ligament. If the appliance which permitted or caused these conditions to arise be removed

then the soft tissues have not sufficient resistance to prevent the tooth, or teeth, being bitten back to their previous position. This conception does not ignore the possibility of the alveolus developing around the tooth when pathologically over-erupted, but it conceives this to be a slow process, so slow and uncertain as to render it unreliable as an assistance to curative efforts. This, if I have read correctly, is the experience of most, and justifies the view often expressed that cases, treated on the basis of pathological over-eruption, usually relapse.

The first condition, therefore, necessary to success is that the treatment should be undertaken at a time when we can allow, or cause, a physiological over-eruption. In other words, in my opinion, we are not justified in commencing treatment except during the eruption of either the first or second molars. It happens that all the cases I have treated have been during the second period.

This method I have now tried for several years and with a large measure of success. It is not put forward as a panacea. Failures will occur, but I am more inclined to regard these as due to faulty technic rather than to any fundamental error of principle. There are also cases which are complicated by unilateral forward movement of the molars, often due to early loss of the deciduous molars due to their early neglect, caused in hospital cases by the total inadequacy and often inefficiency of the work in school dental clinics. The method has this great advantage, that in the forward position the lower incisors cease to impinge upon the upper gum. There is room, as an accessory measure, to correct the undue proclivity of the upper incisors. It avoids that cruel and crude method of obtaining space by grinding down the incisive margins of young and sensitive teeth.

In almost all these cases when the mandible bites forward it is apparent that the upper arch is too narrow to allow normal occlusion of the molariform teeth in this position. My first step has always been to expand the upper arch and for this purpose I regard the use of the Badcock screw to be the best and simplest method. The raising of the bite can be commenced at once by capping a molar, in my cases the first permanent, with a metal cap. For capping one tooth vulcanite has not proved to be sufficiently strong, and although our reliance is placed upon the elongation of the second molar there is no obvious reason why the premolars should not also be allowed at the same time to rise up and move down. This plate, as Badcock demonstrated, can be made with an inclined plane. Only a relatively short time is necessary to obtain the expansion, and then a simple plate with an inclined plane and metal molar caps is inserted. Thereafter we have simply to wait till nature does that we wish.

The models shown and the patients who are present are chiefly from the Royal Dental Hospital. It was the coincidence of there being this little group in various stages of treatment and the assistance of the demonstrator, Mr. Evans, who kindly collected them together, that rendered it possible for me to show them to you.

Figs. 6 and 7 show a case of inferior retrusion in a boy of four years and five months of age, who is under the care of Mr. Pitts, and to whom I am indebted for the loan of the models. Figs. 8 and 9 show the dental arches of the same case. The narrowness of the upper arch compared with the lower is well marked. There

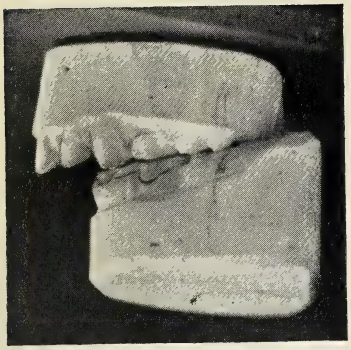


Fig. 6

Fig. 7

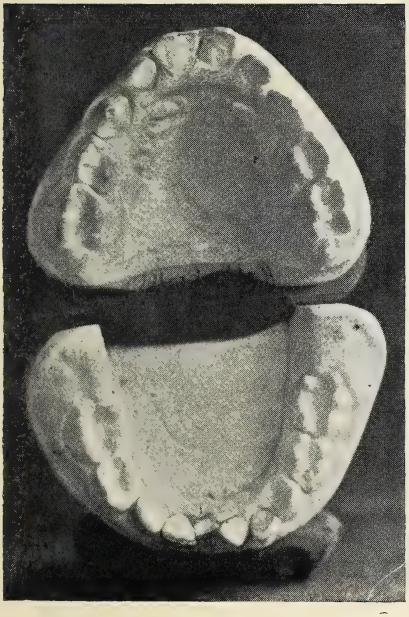


Fig. 8

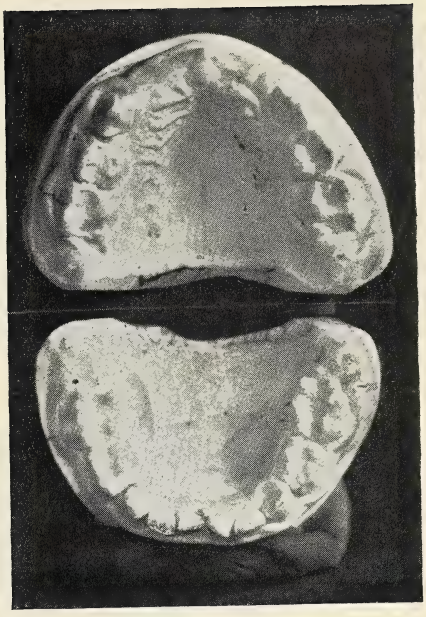


Fig. 9

Fig. 10

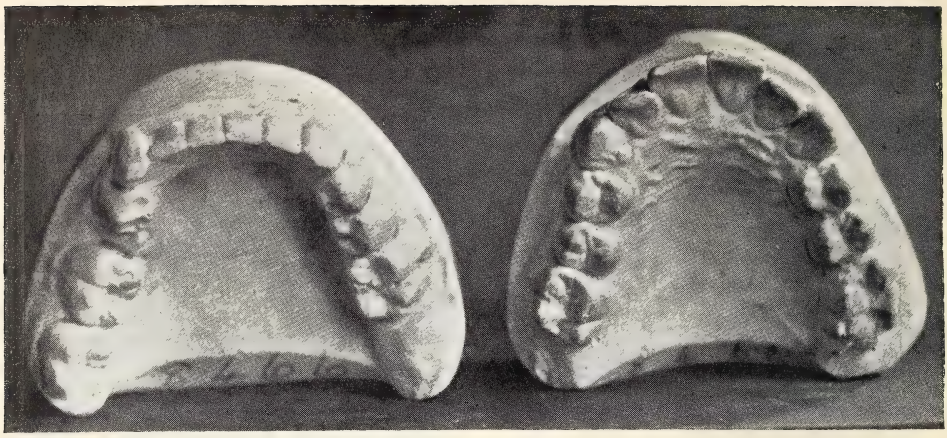


Fig. 11

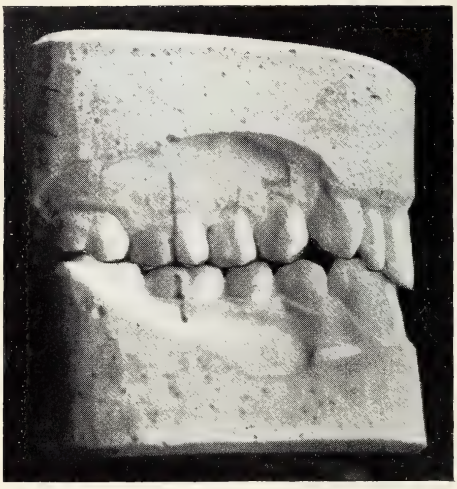


Fig. 12

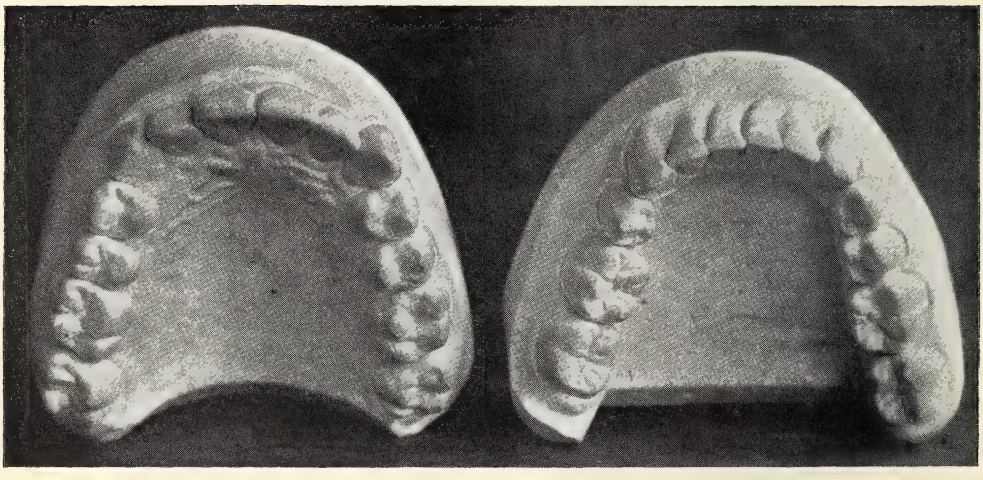


Fig. 13

Fig. 14

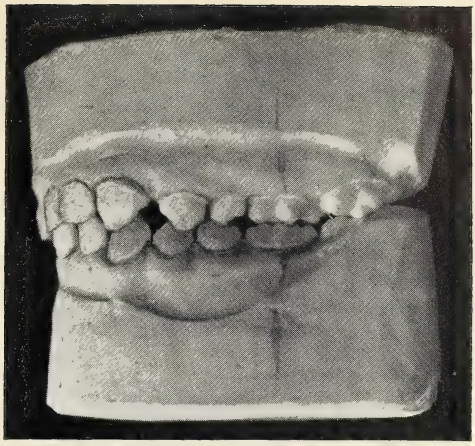


Fig. 15

Fig. 16

Fig. 17

A re-photograph taken from amongst a group in an old photo-print. Much enlarged.

Fig. 18

Fig. 19

would not appear to be any advantage in commencing treatment till the first permanent molars are about to erupt, and the absence of incisor teeth would seem to deprive the child of any motive to bite forward. In my experience a willingness, or rather a desire, to bite forward is an important factor in obtaining a good result.

Fig. 10 shows the models in occlusion of a boy of about 13 years of age taken in February, 1921. It is a case of marked inferior retrusion with the teeth in post normal occlusion and the lower incisors biting on the gum behind the upper teeth. Fig. 11 shows the same models placed side by side to illustrate the narrowing of the upper arch. Fig. 12 represents models taken in December, 1922, when the treatment was regarded as complete, although the pre-molars have not yet come into absolute occlusion. Fig. 13 shows the same models placed side by side. The displaced second lower pre-molar left was extracted at an early date. This I regard as one of the most perfect results we have obtained. The boy was intelligent and willing, and the dresser, Mr. Bernard Rilot, took considerable pains. This boy cannot now retract his mandible, from which I infer that the tempero-mandibular ligament has contracted. Of the boy it may be said truly that we have transformed his face from that usually regarded as representing a weak, indeterminate character to one betokening firmness and will. It would seem fair to assume that as years go by this character will be attributed to him, and indeed the psychic effect may be that so it will develop.

Fig. 14 shows another case, a little girl, and Fig. 15 the same case after treatment. This happens to be a private patient, and the mother was concerned lest the mandible should prove to be unduly prominent, but was reassured on my asking her to compare the size of her own nose, which happens to be somewhat large, and that of her child. Figs. 16 and 17 show the models placed side by side. The lower front teeth have been forced outwards by the inclined plane. This is often an accessory factor in completing the correction of the deformity.

One of the most difficult cases I have been asked to treat is shown in Fig. 18. There is undoubtedly diminution in the size of the mandible and the case was further complicated by the first molars being so hopelessly decayed that their removal was obligatory. Even after treatment had proceeded for two or three years, and whilst wearing a plate with an inclined plane, her mandible when much depressed moved backwards to an astonishing degree on opening the mouth, and at one period of the closing action a distinct step was seen as the patient, more or less involuntarily, moved the mandible forward to allow the mandibular teeth to occlude with the maxillary in a normal position. Upon one side, after many years, the second molars occluded, and the closure was normal, but upon the other they had ceased to rise. I therefore artificially elongated the lower tooth by means of a cap crown anchored by a button in a coronal, carious cavity which had developed. The effect of this elongation upon retaining the mandible in normal occlusion is very marked and seems to justify the previously expressed contentions with regard to this matter. The patient and I trust that later the third molars may over-erupt and complete the treatment. Fig. 19 represents the patient when "on parade," if the expression may be allowed, and indeed the improvement is remarkable, but the

curious step-like movement of the mandible still persists upon extreme opening of the mouth. This patient is extremely tall. In estimating the value of treatment the growth of the child must be considered. A retreating chin when looked down upon is not nearly so abhorrent as when the face is on the line of vision, and far less so than when, as in this instance, the average person must needs look up at it.

[I have purposely omitted a written account of many cases shown at the meeting. Without an excessive number of illustrations the description of them would be impossible. The models of my private cases were thrown away upon moving my professional quarters, when in one wild, but joyous, moment I cast away the litter of years.]

Discussion.

The President said Mr. Dolamore had given the members a great deal to think about; his paper had been exceedingly interesting. It was of particular interest to him personally, because a year ago he had read a paper embodying practically the same conclusions as those to which Mr. Dolamore had come, although he himself was inclined to treat the cases at a somewhat earlier age. Mr. Dolamore's paper contained a great deal that was not present in his own, but the actual lines of treatment were very similar. With regard to what Mr. Dolamore had said in the earlier part of his paper as to the terms "inferior retrusion" and "superior protrusion," a perfect classification had yet to be found. The terms in question were old, and he supposed they would continue to be used until they became absolutely obsolete. The term "post-normal" was always used, yet what "normal" signified had yet to be defined. He thought the terms were sufficiently well understood. The paper was full of interesting points; that in regard to the glenoid fossa was particularly interesting and gave much food for thought. Mr. Dolamore also referred to the examination of dissecting room specimens, but personally he thought that might not be of great value; so many of them were from subjects who were so old that the examination of the joint would prove of very little value to us.

Mr. Dolamore said he had seen bodies in the dissecting room with normal dentitions, but he admitted it would be difficult to get them. He did not see why one should not get them in the post mortem room, because it might be possible to turn up the face without deforming it.

The President agreed that could be done. What Mr. Dolamore said about the stretching of the ligament might be an explanation. The mechanism of the joint needed to be examined very carefully in order to determine which part of it was stretched. It was perfectly true, as Mr. Dolamore said, that if the teeth were extracted the jaws could not be brought into contact. With regard to the appearance of a child, the proportions of the face in a child with the mandible displaced or not advanced caused an appearance that was pleasing to the parents, the features really becoming balanced at so early an age. To alter that appearance often meant, as Mr. Dolamore said, that the mother would bring the child round and say its beauty was being spoiled. Most orthodontists would have experienced this. He agreed almost entirely with what Mr. Dolamore had said, but personally he would be inclined to commence the treatment at an earlier age. He had found, like Mr. Dolamore, that the children were unable to retract their jaws after establishment of the condition desired.

Mr. Highton asked whether, in constructing the plate, Mr. Dolamore capped the 6 year old molar only, and whether he had any difficulty in that connection if the molar was depressed, or whether he capped the pre-molars as well as the 6 year old molar.

Mr Steadman had been very interested in what Mr. Dolamore had said about cases of superior protrusion, which was really in opposition

to what was taught in certain quarters. He thought there were certainly some cases that must be put down as post-normal, but it was extremely difficult to tell whether to diagnose between a post-normal occlusion or superior protrusion, and he would like Mr. Dolamore to give some guidance on that point. As was stated in the paper, the mandibles seemed to be very normal when in fact they were definitely post-normal. The point which struck him most was the difference between pathological over-eruption and physiological over-eruption. That was a most important point, and no doubt accounted for the fact that many people who tried to bring the mandible forward failed, since the whole thing went back so quickly.

Mr. Harold Chapman entirely endorsed Mr. Steadman's remarks in regard to the paper. One point occurred to him in connection with physiological and pathological over-eruption of the teeth, namely that if Mr. Dolamore waited until a child was 12 years of age in order to produce the physiological over-eruption, was it not necessary for the teeth which had already erupted—the first permanent molar and all the pre-molars—to over-erupt pathologically, in order that they should come into occlusion ? He would like to hear Mr. Dolamore's opinion on that. Another point on which he would like to hear Mr. Dolamore's views, and which was really the same question in another form, was as to whether he thought the treatment of the girl whose case he had shown last would be as successful as that of the child whose models had been shown first, one being aged 12 and the other about 6. He had mentioned at the Council Meeting earlier that evening that Mr. Friel had asked him to suggest to the Council that they should make some suggestions as to lines of work on certain problems which the members might investigate in connection with their work. It seemed to him that Mr. Dolamore had offered some very valuable suggestions in that regard, and he sincerely hoped the Council would formulate some questions which all the members could investigate quietly during their daily work, and the total results of which would be, he thought, extremely valuable.

Mr. W. J. May thought the best time to secure physiological over-eruption would be about the age of 7, for then one could get physiological over-eruption of the six year molars by capping the temporary teeth. He would like to know what experience Mr. Dolamore had in treating children of that age ; most of his models were of older subjects.

Mr. Schelling said that the previous week he had treated a case on the lines indicated by Mr. May. Eight or nine months ago he put in a plate very similar to that mentioned by Mr. Dolamore to allow the lower incisors to come forward, and possibly to shorten. The plate had now its desired effect, and he had removed it. The child was now about 7 years old, and he proposed to wait for some years before doing anything else.

Mr. Packham thanked the author for his extremely interesting paper, and commented on the frequency of the condition dealt with. It almost seemed as if every child one saw had some degree of inferior retrusion. That led one to wonder what the cause of it might be, and it had occurred to him that possibly it was a question of two things, mouth-breathing and function. With inferior retrusion of the mandible, if a child bit with it in that position that bite would be an inferior one from the point of view of function. A person suffering from the deformity in question could not bite or chew his food so well as one with normal occlusion. That was brought out when one made dentures on the Gysi three-point articulator ; in those dentures one nearly always found that the lower incisors had to be almost edge to edge with the upper incisors. If with inferior retrusion the bite was a less functional one than with normal occlusion, what was the cause of that ? It seemed to him the whole thing was bound up with the fact that we did not use our teeth as much as we used to do, and nature said, " You are not giving your teeth as much work as I have made them to do, and therefore I will give you a less functional bite." If one could get children who one thought were likely to have this condition to gnaw and chew

to a greater extent, the trouble might be largely overcome. On one occasion he had had a boy brought to him whose parents were very disturbed because he would never chew anything. At two years of age—he was now five—he would take a piece of meat in his mouth and, rather than chew it in small pieces, he would deliberately go to sleep with it in his cheek. A biting plate was fitted to bring the mandible forward and allow the first permanent molars to erupt, and now the boy bit the plates to pieces. He had already got through three plates! It seemed to him, therefore, that function was really an important factor in the etiology of that condition, as well as in mouth breathing. He would like to ask Mr. Dolamore what evil results followed the non-treatment of such cases. Most of the cases Mr. Dolamore had shown had been of a very pronounced type, but one met with many cases which were not so pronounced, and which made one wonder whether or not to interfere. Sometimes the mother would say, "This boy is perfectly comfortable; he can chew the food he is given; why interfere?" One could, of course, expatiate on the beauty point, and on the fact that perhaps he would not get into Parliament, but what else was there to be said? He would like Mr. Dolamore's view on that. Perhaps Mr. Dolamore would also be kind enough to elaborate somewhat his reason for the contraction of the upper arch.

Mr. NEWBOLD, referring to the case of the boy who went into the Army and grew third molars with a forward bite, asked whether Mr. Dolamore had seen him since and could say whether his other teeth had come down and met.

Mr. HAROLD CHAPMAN said the last two speakers had suggested certain other points he would like to mention, although they hardly referred to Mr. Dolamore's paper. He thought habit might be bracketed with function as a cause of malocclusion. He had been told recently, although he did not know what authority there was for the statement, that unless a child learned to suck in the first two or three days after its birth it would be very difficult for it to do so, and it probably would not do so in the correct physiological manner. The same applied, he was told, to chewing; if a child did not learn to chew at the right time, immediately after weaning, it was very difficult to train him to masticate his food correctly. The child Mr. Packham referred to had probably never learned to chew at the right time, and it had now had to be trained to do it instead of learning to do it in the normal way. With regard to the other case referred to, he had a child at the hospital recently who was about 3 years of age. The mother was a Class III case, and she noticed that the child was also in the same condition. She must have been a very intelligent woman, since it was scarcely obvious in the child. She was anxious that her deformity should not be repeated. He told the mother she should endeavour to make the child practise getting her lower jaw behind. When he saw the child three weeks later, it was biting normally.

Mr. STORDY said Mr. Dolamore had mentioned the drawing forward of the jaw. He would like to know whether that drawing forward was actually due to the sliding of the alveolar portion on the body of the jaw, or to a change in the joint. If it was due to the former, the results were likely to be much more permanent than if it was due to a change in the joint; if it was due to a change in the joint he feared there would be a relapse to the original condition after a time.

A MEMBER asked what happened to the condyle when the lower jaw was brought forward. Normally, in the case of a child of 10, or any child which had not attained full growth, the mandible was tending to grow backwards; at any rate, it had got to grow to its normal size, and he did not see why the condyle head should not grow backwards as well. When one pulled the lower jaw forward, the head of the condyle was naturally in advance of its normal position of rest, and he did not see why it should not grow backwards until it got into its normal position.

Mr. DOLAMORE, in reply, said he entirely agreed with the President that the proper moment to treat cases was undoubtedly when the

deciduous molars were in place and the six year old molar was about to erupt, always provided that the deformity existed at that period. On that he had very little evidence to offer. In the case of the little child who was his own patient, he certainly did not notice the deformity when the deciduous teeth were in place. It might be that the fault was his, that it did exist and he had not noticed it; but he wondered whether, in some cases at any rate, the deformity did not arise during the eruption of the permanent teeth. That was a matter which a Society such as that he was addressing might well investigate, and was the reason why he suggested investigating the teeth at such an institution as the Foundling Hospital, where, in view of the number of post-normal occlusions one saw in an Out Patients' Department, it was reasonable to presume there must be a considerable number of such cases at the time when they should be treated—if they were then in existence. On that point he would very much like to have more information. One point he omitted to make in regard to the treatment he advocated was the comparative ease and inexpensiveness of it, which placed it within the reach of quite poor people. There were only two or three plates to make. First of all there was the expansion plate, which one might hope would do all that was required. If it did not, a second expansion plate might be necessary. A child could turn the screw of Badcock's expansion plate himself; it was not necessary for the dentist to see it often. Then another plate with an inclined plane must be put in, which must remain until the treatment was almost complete, when a retention plate was inserted. It seemed to him that if the method he advocated was as successful as he hoped it was and claimed it to be, it put within the reach of quite poor middle class people the possibility of having such deformities corrected, a thing they would be unable to do were the treatment elaborate and expensive. With regard to capping the teeth with an expansion plate, he was rather inclined, especially in cases where he wanted the teeth capped, to cap the pre-molars as well as the molars, chiefly because he held that if the plate was to work it must go home with a click and stick there; otherwise when the screw was turned the plate dropped down and the teeth did not move. Afterwards he only capped the 6 year old molars, and for that purpose he generally had a metal cap made, because quite obviously a vulcanite cap would be constantly breaking and a source of worry and annoyance, whereas a metal cap would almost last until the teeth had over-erupted. He freely admitted that his division into pathological and physiological over-eruption was open to criticism, and he admitted that over-elongation of the pre-molars might always be described as pathological. A 12 year old molar elongated physiologically, however, was going to stand stress. It was obvious that, taken over a period of years, a tooth did elongate; his point was that elongation by pathological process was so slow that one would have to wait years to be able to put the stress on it, if there was not a tooth which was elongated physiologically to take the strain off those which elongated pathologically. With regard to the case of the boy who went into the Army, unfortunately he was killed; but as a matter of fact there was no need for elongation of the teeth in his case, because, as had been explained, he bit forwards to avoid the pressure on the back teeth, and consequently his premolar teeth were in occlusion. One could find, by putting one's lower jaw forwards that one avoided pressure on the back teeth, but these teeth would be in occlusion. There might be some adaptation, but he did not think any great elongation was necessary. In London, at all events, the number of people one saw with slight posterior occlusion was very great, and one had to make up one's mind whether the deformity was sufficiently great to need treatment or not. One was apt, he thought, to take too short-sighted a view, and to regard a slight deformity from the point of view of the child up to, say, 25 years of age, forgetting that 25 was only the beginning of life and that, on the average, the teeth should last some thirty-five years longer. He doubted whether it was right to lose sight of what might happen after the age of, say,

when the teeth began, as they would, to elongate. It was conceivable that even with slight inferior retrusion it might be desirable and worth while to raise the bite slightly. After all, it only meant a vulcanite plate with a gold cap over a couple of teeth, and in six months the whole thing would be over. It was simple and inexpensive, and it was conceivable that it might be worth while treating slight cases in childhood, not with regard to the earlier period of life but to what one thought might happen after the age of 45 or so. It was quite obvious that where there was an edge to edge bite, the teeth would remain firm for years longer than if there was overlapping. He remembered that once while acting as locum before he was qualified (a thing which was allowed in those days) he saw a patient, who was then 80 years of age. He had an edge to edge bite, and his teeth were firmly implanted. He celebrated his 80th birthday by running races with his yokels, so that not only were his teeth firmly implanted but it might be assumed that that had contributed to his health and so prolonged his life. Taking a broad view, therefore, it might be worth while to treat small cases of overlapping in children. He had been asked whether the change was in the jaw or in the joint. He thought there could be no question but that it was in the joint. He did not think it would be possible to produce a change in the alveolus in a couple of years such as had occurred in the completed case he had shown. It must be remembered that, even if it were necessary for the joint to be remoulded about the head of the condyle, it was perfectly possible for it to occur. It was well known that a child with a dislocated hip could have a new joint moulded around the dislocated head of the femur, and, if that could take place, why should not the glenoid fossa fill up around the head of the condyle? It seemed to him perfectly reasonable to expect it to do so. Whether the description given by Quain, that the head of the condyle rested on the back of the glenoid eminence, was correct or not hardly mattered; if it was, one would not need to get the moulding; if it was not, the joint could be altered. At all events, the point was that to begin with it was a bite of accommodation. If one obtained a comfortable bite then the child would adopt it. The same thing occurred in cases of inferior protrusion, where the incisor teeth needed very little pushing out, but the child protruded the lower jaw more than was necessary. One could often push the jaw back so that the teeth came edge to edge, and a very slight movement forwards of the incisors corrected the difficulty. That was another instance of a bite of accommodation. He had mentioned that many London children suffered from inferior retrusion. It seemed to him that some investigation was needed into the different forms of malocclusion—and normal occlusion, possibly—occurring in different parts of the country. A short time ago he had had to go down to a school clinic at Derby, and it struck him that the children's arches were distinctly different from those which he saw in hospital practice in London. Derby was a limey district, and he could not help thinking that the arch was distinctly different from London types. He saw cases there of slight superior protrusion in which there was no inferior retrusion. He would like to see some investigations made with regard to the different types of bite and different types of occlusion which occurred in different districts. With regard to the narrowing of the upper arch in most of the cases of inferior retrusion, which he had seen, it was found, on putting the mandible forwards, that the lower arch was too large for the upper, and it was necessary to expand the upper to get normal occlusion. He could not explain it; he could only say it was so. In conclusion, he thanked the meeting for their patient hearing, and hoped that those who had not tried the method he advocated, would do so.

On the motion of the PRESIDENT, a hearty vote of thanks was accorded to Mr. Dolamore for his excellent paper.

Casual Communication.

"Models of a Case of Class II, Div. I, at 5 years and 7½ years of age."

Mr. H. E. Marsh regretted that the models of the case at 5 years of age had been mislaid, and he was unable to show them to the members. He could only exhibit the models taken at the present day, and describe as well as he could the condition at 4 years and 10 months. If one took the models and examined them separately, one might quite well think it was a case of ordinary normal occlusion and lack of interstitial growth, but when the two models were put together it was difficult to say whether it was a case of post-normal occlusion or not. The child was a partial mouth-breather, and at one time it was thought he suffered from adenoids. An operation was performed for their removal, but very little indeed was removed, and he remained a partial mouth-breather. The child had been through a six weeks' severe illness, during which time his mouth had been very dry and he had found it difficult to swallow, so that he (Mr. Marsh) had put forward the view that it might be post-normal occlusion brought about by illness.

Models of the child's mouth at 7½ years of age showed a want of growth in the canine region, both above and below. The upper central permanent incisors had erupted, and the lower permanent incisors, having nothing to meet on account of the post-normality of the whole of the lower jaw, had continued to erupt until they bit practically on the palate, the lip dropping in underneath. It would be seen from the model how the temporary molars in the lower jaw articulated; the lower jaw had been unable to come forward on account of the position of the upper canines. A few months after the upper permanent incisors began to erupt they came down and got bitten forward.

The President thought it unfortunate that the models taken at the earlier age were not available; they would have added greatly to the interest of the case, although it was interesting without them. The fact that the child had been ill was a factor of considerable significance. There was a possibility, he thought, that mouth breathing might become a habit as the result of a raised temperature in a child, a point which had been alluded to in the discussion at the last meeting. If a child is too heavily covered at night, it tends to breathe through the mouth. The same might happen to the child if ill, and that might establish a habit. Mr. E. D. D. Davis, in a recent paper read before this Society, was inclined to think that habit played an important part in establishing mouth breathing. The post-normal condition was largely brought about by the jaws being apart and the weight of the larynx and the tongue maintaining the jaw in a backward position rather than allowing it to develop normally. It looked very much as if that might have happened in the case under discussion. Whether the locking of the temporary canines was sufficient to hold the bite it was difficult to say.

Mr. Harold Chapman said Mr. Marsh's communication brought out a very important point, namely, that one should collect models of cases at varying ages so that the changes which took place could be observed. Mr. Marsh stated that the case appeared to be normal at 4 years and 10 months, but that now there was serious malocclusion. He had recently seen models of several cases which, at the same early age, made one think malocclusion was likely to occur. Those cases were not treated, and the result, at 8 or 9 years of age was fairly good; in one of them, which personally he would have thought, seeing it at the earlier age, required treatment, the occlusion was remarkably good; at the age of 9 there was only one lower pre-molar that could be found fault with. If one were to take models of one's patients at such periods, one would be able to learn a great deal about the growth and development of the jaws and of occlusion.

Mr. Marsh, in reply, said he had been very much impressed by the President's remarks about habit, because it was difficult, in the case

he had referred to, to assign any other cause for the mouth breathing which now existed other than the habit that was formed when the child was ill. The effect on the child was very bad ; his nasal passages were very small, though clear, and the whole of the lower half of his face was undeveloped and narrow. He had not suffered from adenoids, and apart from the one illness which had been mentioned his general health was good and his general physical development excellent ; but he had now got the typical shoulder blades of a mouth-breather, his chest was narrower than it should be, and he slept with his mouth open. Valves had been tried without success ; if the valves were left out the jaw at once dropped open.

An ordinary meeting was held on Monday, May 7th, 1923, Mr. Warwick James presiding.

The following members were present for the first time, signed the obligation book and were formerly admitted by the President : Mr. Robert Lindsay and Mr. J. N. Strickland.

The minutes of the ordinary meeting of March 5th, 1923, were confirmed and signed. The following gentlemen who had been passed by the Council for election were elected *en bloc* by show of hands : Mr. Ralph Bout-Wood, L.D.S. ; Mr. Edgar D. D. Davis, F.R.C.S., L.D.S. ; Mr. T. Martin Hughes, L.D.S., M.R.C.S., L.R.C.P. ; Mr. Harold F. Metcalf, L.D.S.

Dr. Georges Villain of Paris read a paper, "The Mechanism of the Human Denture and Physiological Orthodontic Treatment."

The President, in introducing the reader of the paper, said he was sure members would have great pleasure in listening to our distinguished confrère, Dr. Villain. Particularly would he be welcomed by those who had met him in France during the war.

(The transcript of Dr. Villain's paper had not been received at the time of going to press with 1923 Report. It is hoped to include it in the Report for 1924, together with the discussion.)

An ordinary meeting of the Society was held at 11, Chandos Street, Cavendish Square, on Monday, October 1st, 1923, at 8 p.m., Mr. W. Warwick James, President, in the chair.

The following new members signed the Obligation Book and were formally admitted to membership of the Society : Mr. Ralph Bout-Wood and Mr. Harold F. Metcalf.

The following candidates were elected to membership : Mr. L. J. Newbald, 150, Carshalton Park Road, Carshalton, Surrey ; Mr. A. S. Cross, 11, Buckingham Gate, S.W.1 ; Mr. L. F. Fouraker, 29, Central Hill, Upper Norwood, S.E.19.

Casual Communication.

"Two Unusual and Completed Cases." By Mr. Cale Matthews.

(*See illustrations opposite page* 57).

The first was the case of a boy aged 12 in July, 1921, and the first model is dated in December of that year.

The history is very unsatisfactory. An expansion plate had been worn for the upper teeth, but no models are forthcoming to show the original condition before any treatment was started, and the first shows a very unusual state of things. The dentures are complete with the exception of $\underline{3 \mid 3}$. Teeth well formed, free from caries with the exception of two or three small amalgam fillings. An accident resulting in rather serious damage to the nose and some permanent deformity cannot account for this unusual width of the maxilla, as no damage was done to the teeth or mouth. This can be taken as true, as the boy's father is a doctor.

Actual measurements of the models brought with the patient at the first visit and those taken in December, 1921, are identical. It will be seen that any attempt to articulate the models shows the width of a molar tooth in excess in the upper model. Actual measurement: upper 41 mm., lower 38 mm. The bite must have been quite one of convenience. Approximation of the models gives a distal occlusion of the first permanent molars and a point-to-point articulation of the premolars. Considerable spacing of the lower premolars should be noticed. Measurements, palatal sulcus to interproximal space, 1 | 1 *i.e.* 6—1 | = 36 mm. | 1—6 34 mm. in first models. Completed case, 40 mm. in upper, 37 mm. in lower, a reduction of only *one* mm. in width; but in forward development the difference is greater, 6—1 | = 39 mm. against 36 mm., and | 1—6 = 37 against 34 mm.

Treatment was started on December 22nd, 1921. The common difficulty of school terms to be kept necessitated a type of appliance needing the least adjustment. Forward movement of the upper incisors seemed to be the first and most urgent movement; this would liberate the mandible, and if successful would in that forward movement reduce the excessive width of approximation. Also a lateral pressure seemed to be necessary to narrow the posterior maxillary teeth. The distocclusion of the lower premolars due to the bite and the spacing had to be overcome. It was hoped that the eruption of the second permanent molars would have sufficient forward driving force to place the molars correctly mesio-distally provided the pre-molars were unlocked. The overbite was approximately one-third excessive. Ribbon arch molar bands were fixed on 6 | 6, bracket bands on 2—1 | 1—2 with a straight forward-driving force. The arch was sprung to exert contraction force on 6 | 6. The lower teeth were also treated with the same appliance except that the incisors were left free. Bracket bands were placed on 5—4 | 4—5 with cleats soldered to the arch, and instructions given to work the arch forward by the sleeve nuts. This obviously maintained the molars in their original position and would not correct the distocclusion, but if the pre-molars could be carried forward to their proper position in one term it was hoped the delay would not prejudice the normal eruption of the 7 | 7 and that 5—4 | 4—5, once in position, could easily be retained and 7—6 | 6—7 watched.

The technical difficulty of working this apparatus proved too much for the patient, and a removable appliance was designed with interstitial spurs driving forward; the sharp-pointed occlusion rendered this a difficult movement, but eventually it was successful, but not until a bite plate had been worn for some time to reduce the overbite. This case is unusual in so many features that it was interesting from a technical standpoint and it proved the necessity of immediately changing an appliance should that prove to be inefficient. Too often an appliance is persevered with, and although theoretically it should do the work, it may be some little point has been overlooked which negatives the forces which are the directly operating ones, or, as in this case, the simple manipulation of an appliance to the operator is quite an impossible task in the hands of the patient or attendant. A simple inclined plane retention plate was worn in the upper and a vulcanite plate in the lower regularly for two terms, but this is now discarded and only used to prove that there is no movement of individual teeth.

The President said the case had a great number of points of interest, and he thought one of the most interesting was the movement of the molars, which had been brought about by giving them sufficient space in which to move. The movement forward was associated apparently with the eruption of the second molars. A point in the case was that where the teeth were widely situated it was very often easier to correct them than where they were crowded together.

Mr. Cale-Matthews then proceeded with the second case. The

patient was a girl aged 21 in August, 1922, and the first models were dated February, 1923. There was unilateral distocclusion, 2—1 | 1—2 in labio-version, | 5 in torsi-version. Teeth of excellent quality, large and well-formed. Patient distressed by the deformity of the prominent incisors and inability to keep the lips closed. No history of adenoids but an appearance of previous difficulty in nasal breathing, but perfect freedom at present.

With the teeth occluded the dorsum of the tongue was plainly visible. Patient was very anxious to have treatment to overcome the deformity. It was carefully pointed out to her that her age (21½ years) was against a perfect success. She decided to proceed with treatment.

Molar anchor bands were fixed to 6 | 6 and bracket bands to 3 | 3. A ribbon arch was placed with expansive force on 3 | 3 only. At the end of six weeks the 3 | 3 had expanded 3 mm., from 24 mm. to 27 mm., also the expansion arch had acted as a depressing force as seen in models April 19th; the left | 3 was prominent. The patient was anxious to have a less conspicuous appliance. A high-up labial bar soldered to swaged bands on 6 | 6 with a removable palatal retention for 3 | 3, with depressing spurs and rotating T pieces on 2—1 | 1—2, was worn for three weeks. A retention plate of vulcanite with a labial retention wire (adjustable) was inserted to be worn at night.

The interesting feature is the short time involved in treatment, no functional inconvenience and no lateral movement of 6 | 6. Patient is able to close the lips and to sleep with them closed, and incidentally is very pleased with the result.

The PRESIDENT said Mr. Matthews' second communication was also of considerable interest. The fact that the patient was an adult over 21 when the treatment was undertaken, was a point that impressed itself upon one. He himself felt that the older the patient the more possible it was to get the patient's co-operation in the work, a fact which frequently compensated for the disadvantages of age. In the few cases in which he had attempted to effect an alteration in the position of the teeth in adults it was astonishing how quickly he had been able to carry out the work. It was perhaps a little difficult to discuss the cases without carefully going over the models.

A CASE OF MULTIPLE IMPACTION OF PERMANENT TEETH.

By MR. BERTRAM SAMUEL.

(*See illustrations opposite page* 57).

This is a case of multiple impaction of permanent teeth. Many cases have been recorded of the impaction and non-eruption of teeth, but I have not come across anything presenting so many puzzling features as the following: A. H., aged 10, is a thoroughly healthy youngster—he has just been examined by a well-known consultant physician who expresses himself as quite satisfied with his physical condition. He was breast fed and of his infancy there is nothing untoward to record. He is intelligent and well up to the mental standard of boys of his age at the preparatory boarding school he attends. You will note that seven of the permanent teeth have not erupted, and radiograms show that:—

1 | is present with apex interval to 2 |;

| 3 is directed to | 2 obliquely towards median line;

6 | 6 are;

2 | 2.3 are present.

I show casts, photographs and radiograms of the boy and think you will agree that this is a somewhat puzzling case in which to be asked to give an opinion.

The PRESIDENT thought the members of the Society might congratulate themselves that the patient did not come to them for

treatment because the circumstances were extraordinarily difficult in dealing with cases of that kind. That had been the experience of all who had had cases to deal with where a large number of teeth had been absent. Each case had to be dealt with on its merits, as no particular laws could be laid down with regard to them.

Mr. PITTS said that in the American journals a great deal of stress was laid on impacted and non-erupted teeth as a cause of all sorts of nervous disturbances, even leading to insanity. In the case shown the impacted teeth did not lead to any lack of intelligence.

Mr. B. BULL asked Mr. Cale Matthews how long he intended to keep retention in his case.

Mr. CALE-MATTHEWS thought it would be more or less a permanent retention. The patient would have a plate and would wear it whenever she thought it necessary. He had only had one case of the same age, a case of marked distal occlusion. The girl was going to Germany to study, and he saw her some few years afterwards and she was still wearing her retention plate at night.

Mr. D. M. SHAW gave a paper on

FORM AND FUNCTION IN TEETH, AND A RATIONAL UNIFYING PRINCIPLE APPLIED TO INTERPRETATION.

THE "Maximum Shear" theory of dental mechanisms was first presented in a dental journal over ten years ago. Since then three or four papers have been published with the object of drawing attention to the leading principle therein suggested, and to provoke discussion on some of the definite interpretations that had been worked out in regard to certain specific features in the teeth of man.

Of the several theories bearing on the evolution of teeth, the Cope-Osborn tritubercular theory stands out alone in claiming to be based upon a definite *leading or unifying principle* for explaining the origin and historical sequence in the step-by-step modifications of the patterns of molar teeth. In the tritubercular theory the declared "unifying principle" in point of fact consists in the singling out of a particular shape or pattern as the prototype, and in tracing and identifying this prototype and its main elements as far as possible throughout the full range of mammalian molar types. Leaving out of discussion its soundness or possible defects, and its unquestioned fruitfulness, the so-called "principle" of trituberculy can be said to operate almost solely by seeking to demonstrate the persistence and important influence of a special *pattern*, and there is no recognition whatever of a persistent or predominating mode of action, or of any *mechanico-physiological principle*. And although Osborn, in common with some other eminent workers, had long felt that some such unifying and directing principle must underlie the varied but definite and co-adapted transformations in teeth, and had earnestly searched for it, in the end he falls back ineffectually on predeterminism or some unknown "law of predisposition."

The writing cut with such precision upon the complex patterns of teeth may indeed be hieroglyphics, but, even so, it was surely no random and meaningless scribbling. More probably it was a real organic language in which the principles of tooth design and mechanism were inscribed, and we might yet succeed in deciphering it if first we took pains to learn its dynamic alphabet and master the elements. Now, in the working hypothesis here put before you, it is sought to make the letters, so to speak, of this "alphabet," one by one clearly identifiable as definite morphological features, each of which is separately associated with a definite

and verifiable mechanico-physiological utility or function, and to link up and unify most of these under a leading and ever-present mechanical principle. It is well to note, however, that the small incipient character—so often either passed over unnoticed or referred to as " insignificant," " undeveloped," " rudimentary," etc. —may persist in the type and remain at that stage and yet be constantly associated with a definite physiological utility that no one is entitled to say is non-essential or of merely secondary value.

It will be best first to state a very important fact relating to the behaviour of hard and tough materials—such as foodstuffs—when subjected to different kinds of stresses. *Such hard and tough materials are more easily—with greater economy of effort—broken up or comminuted by* SHEARING *stresses than by compressive or tensile ones.* In the various artificial machines for the break-up and mechanical preparation of tough foodstuffs for man or beast, shear stresses are the ones aimed at in the design and effective working of the machine. And even when there is a considerable degree of brittleness, as in dried cereals prepared for milling, the work at every stage of reduction is mainly done by shearing interaction. It was so in the case of the old stone mill. In modern milling, the " break-rolls " are finely fluted, and by a precise and very delicate co-adjustment of the steel rollers, the husks are neatly removed by the operation of what are nearly pure shearing stresses. In the later stages of reduction to fine flour, a differential velocity is given to the pair of rollers so as to subject the particles further to the operation of those uniquely effective shearing stresses. Other examples and evidence of a quantitative kind have been given in former papers, so that, until the conclusions are called in question, no more need at present be said upon that point. Something will have been gained, and one stumbling block to the understanding of my main hypothesis perhaps removed, if now what is really and properly connoted by the term " *shear* " is the better apprehended.

Fig. 1 (A), (B) and (C) gives the physics text-book illustrations of a *shear* force acting chiefly across one plane, as in scissors; and in the glued prism of india-rubber, acting across many successive planes and producing merely a distortion or change of shape. Alongside is shown, as corresponding to these two extreme or very different examples of shearing action, the teeth (sectorial) of a carnivorous animal, the multi-bladed cheek teeth of a horse, and the nearly flat molars of an elephant.

Seeing then that some time in the past man had discovered the special utility of shearing action and had brought it into his service in an increasing variety of contrivances, we need not be overmuch surprised to find that Nature, with her immense output under the pressure of a ceaseless competition, had also "discovered" that same principle and special utility of shear action. And Nature has indeed applied it, and thoroughly ' tried it out ' in those very organs, namely, the teeth, wherein the elaboration and refinement of tool-like devices is so variously and overtly displayed, and where unquestionably the attainment of a purely mechanical efficiency is the all in all. Almost throughout the vast range of mammalian dentitions, as well as in certain other types, form and mechanism would, I suggest, seem to be very largely determined by this paramount requirement for operating mainly by shear stresses. The relatively very few types that stand as easily recognised

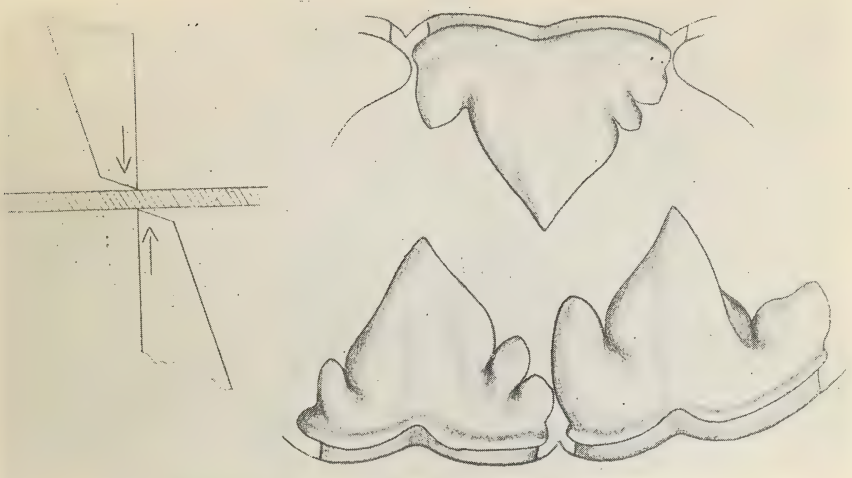


FIG. 1A.—To illustrate the correspondence between a shearing action in a scissors-like tool (on left), and that in the 'sectorial' teeth of a carnivorous animal.

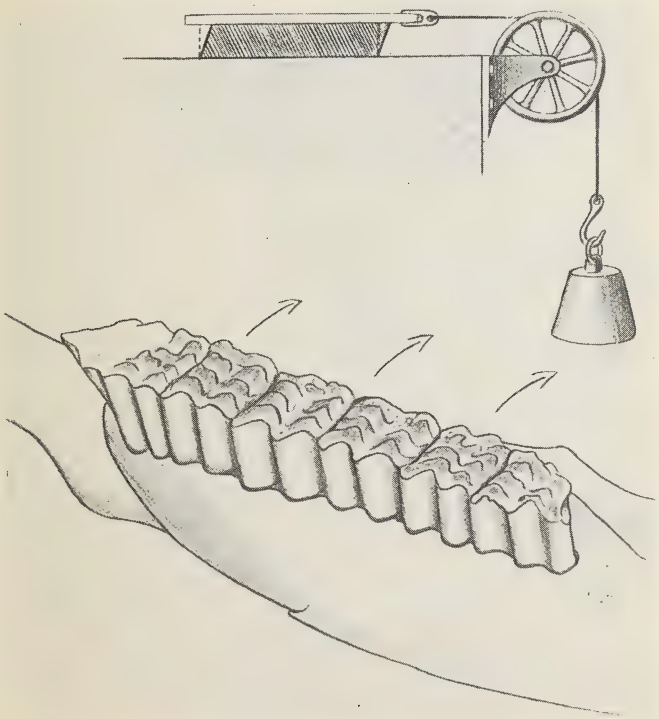


FIG. 1B.—Showing (on top) a text-book example of a "simple shear force" acting across many planes, but producing only distortion of the material (india-rubber); also the potential shearing across the multi-bladed cheek teeth of a horse.

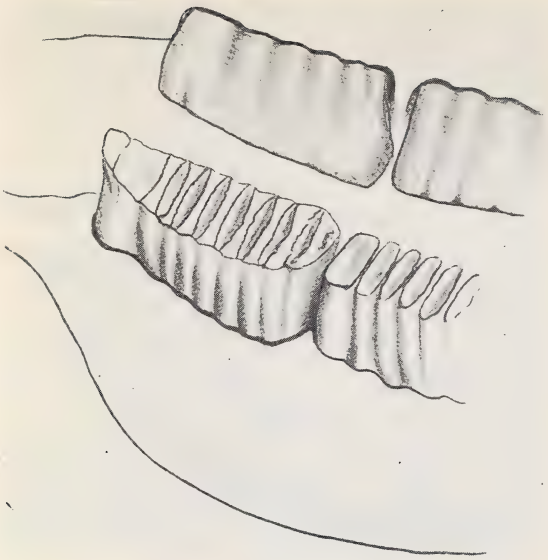


FIG. 1C.—Opposing molars of an elephant, nearly flat; where, with hard bulky food material, there may be more of true crushing and splitting than of shearing action; but with thin material (leaves) shearing forces will predominate.

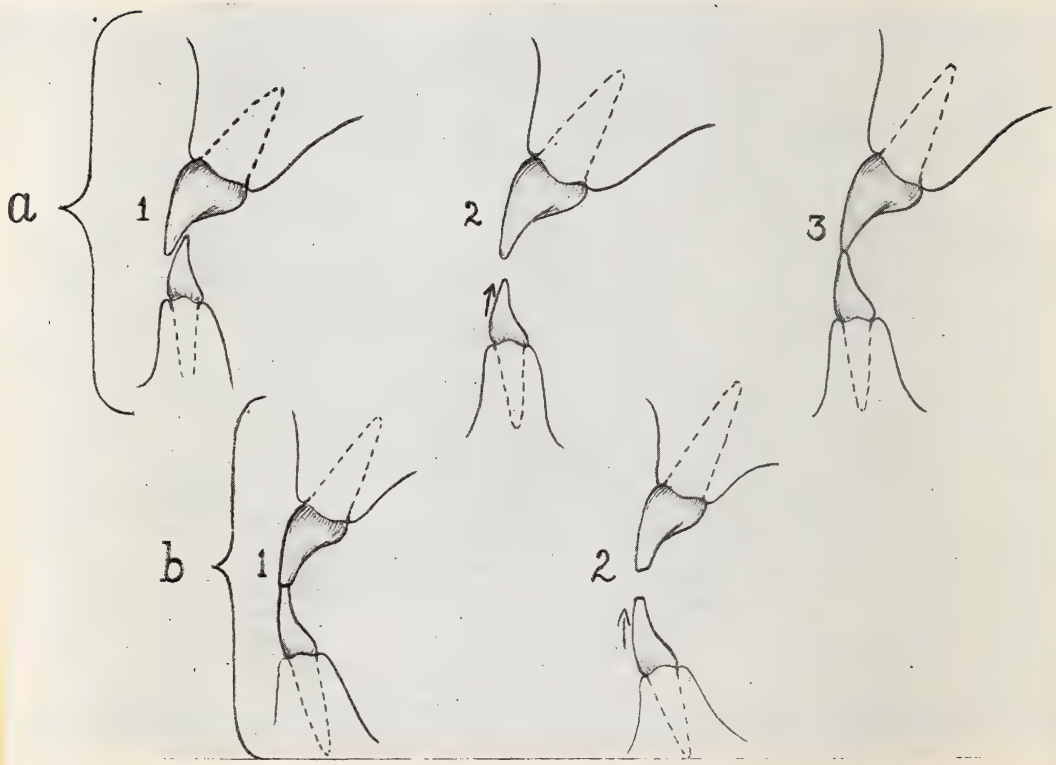
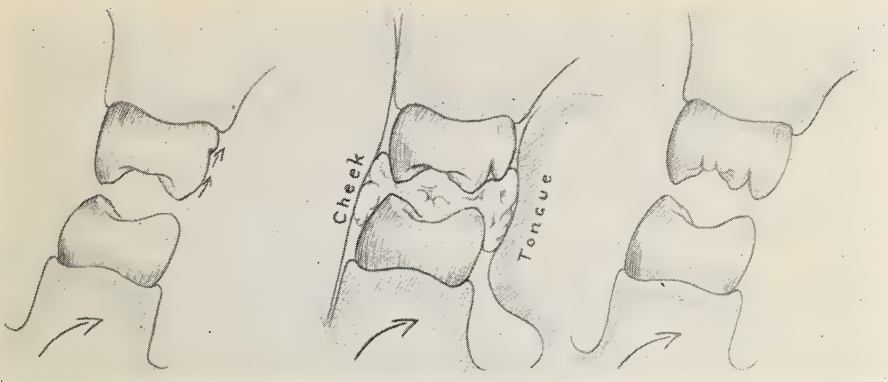


FIG. 2.—Diagram showing in *a*1 the normal occlusion of man's incisors, from which the positions *a*2 and *a*3—"edge-to-edge"—can readily be taken up. The "primitive" edge-to-edge occlusion in *b* is less effective in shearing and in conservation of the hard dental tissues.

FIG. 3.—Three functional stages in suggested evolution of "fifth cusp."



Stage 1.—Incipient feature acting in "chip deflection."

Stage 2.—Tubercle assisting in food-holding.

Stage 3.—Full cusp-size attained.

FIG. 4A.—First deciduous lower molar, showing protective convergence of cusp surfaces and points.

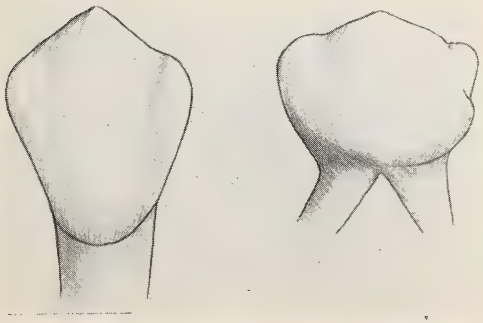
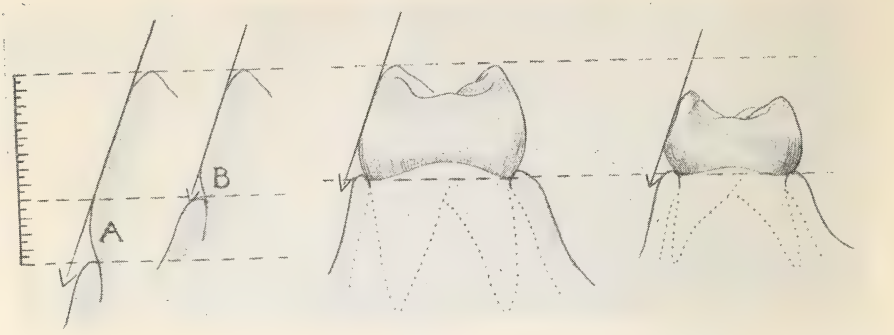


FIG. 4B.—Upper premolar and first deciduous molar: compared to show difference in angle of cusp point.

FIG. 5.—Permanent and deciduous molars, showing (on right) how shorter wall of deciduous tooth is modified at neck to secure the same "factor of safety" in chip deflection.



Gum menaced in B, where neck of (imaginary) *shorter* crown is unmodified.

Permanent.

Deciduous.—Gum sufficiently sheltered by bulbous base.

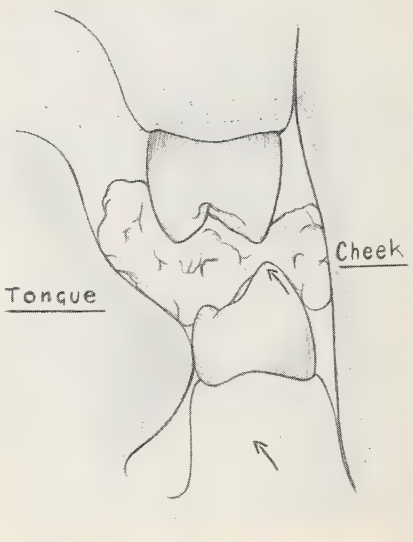


FIG. 6.—Showing prime function of lingual cusp of first upper premolar,—that of *holding* the 'work' (food morsel) in proper position for the shearing thrust of the lower first premolar.

exceptions are in themselves significant and, as it were, negatively instructive in showing that when teeth are so shaped and related that they cannot and do not operate by shear stresses, no fine reduction or comminution of hard and tough food takes place ; or, if comminution does take place in the mouth, these teeth play practically no part in the process.

Turning at this point to meet an imagined interjection, the impediment or doubt may be expressed somewhat as follows : Accepting all that can be said as to the superior effectiveness of shearing action, and granting also that its dominating character and functional value in mammalian dentitions had not previously been stressed or even pointed out—why and how should this obscure hypothesis of ' maximum shear ' give promise of being a useful instrument for investigating the mode of evolution and the physiological mechanism of teeth ? Broadly, the answer is : First, that as artificial and natural machines for the break-up of moderately hard and tough materials operate mainly by shear stresses, it is not irrational to suggest that in any animal dentition, or any given linear series of dentitions, the plan or design of the machine, its unit forms and mechanisms, and the phylogenetic changes therein, must each and all have been very largely directed, guided and controlled by this constant and paramount requirement of functioning mainly by shear stresses. Second, in a machine definitely so ' designed ' and so functioning, the specific or established forms, mechanisms, etc. (however widely varied and diversified they might be—and as indeed we know them actually to be) would not vary or dispose themselves in endlessly indefinite directions or in random formations, but rather be picked out and assembled and correlated in strict and definite response to the needs and special working principles of just that particular type of machine mentioned—*i.e.* one dominated by interactions mainly of shear. What I am trying to bring out is, that if the dental machine were, in its principle of operating, of *some other* distinctive type, say one acting mainly by compression, tension, concussion, or what you will, the various working parts, the habitual direction of thrust, and the details of form and mechanism would then present characters which, while doubtless adapted for efficiency in that supposed type, would yet in recognisable ways be quite different to the characters required and met with in dentitions of the " maximum shear " type. Each such type might conceivably have its own leading mechanical principle holding sway in response to the dominating kind of stresses and strains that were functionally called for. But here we are concerned only with mammalian dentitions, where throughout the innumerable modifications of design, the grip on the fundamental shear principle is hardly ever once slackened. While no doubt the Cope-Osborn triad comes out clearly enough as a *leit motif* in many of the more primitive and simple dental compositions, the " shear " idea even in these is often the significant tone, and it certainly becomes the leading theme elaborated and insistent in nearly all the complex and more refined productions.

The foregoing gives in short outline some idea of what I might call the *general* theory or principle of " maximum shear " as applying to tooth forms and mechanisms. Its step-by-step application to the interpretation of mammalian teeth can hardly be illustrated in this short paper, nor do I for a moment pretend to possess the knowledge and competence required for handling the vast subject.

But in any case a fruitful application of the *general* theory must be yet for a long time delayed, because exact information is almost completely lacking in regard to what I consider to be, in *any* rational theory for the interpretation of dental mechanisms, the two most radical factors. First, *the physical character of the food;* second, *the degree of reduction or comminution effected* before the food leaves the mouth.

Passing away then from the general theory, we turn perhaps more hopefully to the *special* theory as applied to the teeth of man. Here we are in a much better position for studying the two prime factors of character of food and degree of its reduction. And after all, to quote from Dr. F. A. Bather's masterly address, "Fossils and Life" (British Association Report, 1920): "The analysis of adaptations in those cases where the stimulus can be recognised and correlated with its reaction affords sure ground for inferences concerning similar forms of whose life-conditions we are ignorant." It was in that spirit and by that rational method that I, in the paper as first presented, invited your attention to a unit-by-unit observation of what takes place in the human mouth as each pair or group is erupted and brought into functional use. Summarising now those results, and beginning with the deciduous dentition, the following are among the points that seem to emerge :—

1. (*a*) When the deciduous incisors are erupted and in occlusion, the superior group are in most cases observed to be vertically and externally overlapping the inferior group (Fig. 2).

(*b*) These eight incisors—as also of course the very first-arriving pair—have found their way unerringly to a position and relationship which may be regarded as that of normal occlusion. Imagined crude mechanical guides or oral 'vergers' play a very subordinate part in the 'seating' arrangement, if any at all: the directive *growth force* is sufficient, normally. There is, of course, here no need to refer to the part that may be played by Keith's executive *hormones* from this or that important ductless centre, or to cogitate whether indeed the full plan and details may be docketed in some more remote and unapproachable head-office situated inside or outside our marvellous clayey habitation.

(*c*) The overlapping occlusion is definitely a provision for operating by shear stresses. The efficient "shear" principle is thus introduced and actively established in the dental machine *at the very beginning*. There is therefore good ground for inferring that, even at this early stage, the protrusive and lateral motions of the mandible, and the related co-ordinations of joint and muscle action, are called into play and *their character largely determined* in response to the requirements and the special effectiveness of shear stresses. Such movements would have practically no meaning or value in a machine of the non-lapping, edge-to-edge, or the non-shearing type. And in the co-ordinations spoken of, a fine degree of *precision* in the *direction of thrust* has to be provided, and is often called for.

(*d*) These normally-placed incisors can also readily undertake, in addition to their special function by close shearing, those gnawing, biting and nipping functions to which the edge-to-edge or non-lapping dentitions are perforce and entirely restricted. "Edge-to-edge" may or may not have been the normal occlusion in some primitive human races: it certainly is less efficient in function and

in conservation of the hard dental tissues than the arrangement found to-day and in recent and many early types (Fig. 2).

(*e*) Probably tongue or lip biting sometimes happens at this stage; but difficult to verify in children so very young. It may occasionally be the cause of some of those sudden and unaccountable bursts of crying which cloud the smiling blue. The child normally must practise and learn how to masticate much the same as he must practise and learn how to walk. And, as penalties and instructive warnings for errors made, the painful mis-bites correspond to the falls and mishaps in learning to walk upright. But while early functional errors or defects in the organs of locomotion for the most part right themselves or are remediable, a persistently wrong method of masticating, with its related perversions of muscular action and of mental and emotional attitude—to say nothing of consequent malocclusion—will very rarely become rectified by the mere lapse of time, or give place to the rhythmical and healthy activity of normal mastication. In regard to the important question of when a young child may first begin to acquire—or rather, have *forced* upon him—the vicious habit of swallowing unmasticated lumps, we would fain believe that the reflex actions which guard the throat-way have not at this early stage been much blunted in sensitivity, nor just yet been pushed to inhibition by persistent ignorance and bad example in the matter of food and feeding. We do know that when a healthy child is allowed to exercise his first group of finely fluted chisels upon a piece of crusty bread, his untaught procedure then lacks nothing in deft and attentive skill, or in patience, or in placid enjoyment.

2. (*a*) With the increasing intake of solid food, double or multi-bladed teeth are next required in order that fine comminution of the increased quantities may be carried out more freely and efficiently than would be practicable with the single-bladed group. According to my hypothesis, a fundamental requirement at this transition stage is some such modification, or additional elements in the shape of the next-arriving tooth, as will be *definitely adapted to holding—and helping the tongue to hold—the smaller food fragments in proper position for their finer reduction by the obliquely-directed shearing stroke.* And (as I showed in earlier papers) whether a lingual cusp be small or large, its prime utility and function is that of holding the smaller food fragments in correct position for further reduction—an absolutely essential requirement in almost every kind of machine for severing or sub-dividing material. The dentist hardly needs reminding that as one endeavours (with shears or nippers or any other tool) to sub-divide pieces of metal or what-not into progressively smaller and smaller fragments, the always essential matter of holding each piece in proper position becomes progressively more and more difficult. That is precisely the kind of difficulty and need a carnivorous animal would have if we imagine it vainly attempting to sub-divide its tough flesh food into *very small pieces* by the action of its trenchant shearing blades. But the accessory dental element or device required for food-holding is phylogenically not the first but the *second* definite ' step ' or acquirement in that " three-step functional ladder," by which alone an incipient modification can be conceived to advance from its food-deflecting and gum-shielding office, and at length climb to full cusp size. The highly variable " tubercle of Carabelli " was available in the living mouth for tracing the relation between

form and function at each of the three definite steps or distinctive kinds of utility (Fig. 3).

(*b*) In the study of the uniquely-shaped deciduous first molar—described in detail in the DENTAL RECORD, July, 1914, the interpretations arrived at were, briefly: These molars are the first group of edged-and-pointed teeth to come into use. The bluntness (as compared with all other post-canine teeth) of the edges, the obtuseness of the angle formed at the cusp point by the confluence of its cutting edges, and the peculiar way in which the mandibular cusps are drawn together, are conditions all effectively adapted to protect the busy young tongue and cheek, and to reduce the undoubted risk of tongue and cheek biting (Fig. 4).

(*c*) That marked but unexplained characteristic of all deciduous teeth—the bulbous base which overhangs the "constricted neck," can with all reasonable surety be interpreted as definitely adapted to shield the soft investing tissues from injury during mastication. The "chip off-throw" or tangential deflection of hard food fragments is in its angular *direction* the same for both milk and permanent teeth; so that, in point of fact, the *shorter* crown-wall of the milk tooth must have a relatively greater degree of vertical convexity in order to ensure the same or an equally-good 'factor of safety' in chip deflection (see Fig. 5; also *Dent. Rec.*, August, 1909).

(*d*) The remarkable "bucco-gingival ridge," found on all deciduous first molars, is a local accentuation of the chip-deflecting feature, and is uniquely adapted to protect that delicate buccal frænum which, at the period of eruption and for a short time after, is inserted close to the enamel ridge and sometimes springs from the very margin of the gum almost in contact with the base of the sheltering ridge.

3. (*a*) The teeth next set up in the machine, the deciduous second molars, are in the *main features* of crown-form identically the same as the corresponding first permanent molar in at least 80 to 90 per cent. of mouths wherein both units are *in situ* for comparison.

(*b*) But, in addition to being smaller and vertically *shorter*, this deciduous tooth has the sharper edges, and its occlusal surface is more delicately and effectively sculptured and fluted out to produce those edges. The unworn deciduous second molar is—so to say—finer and more thorough in mechanical design and finish. The second milk molar of our modern day is in many respects the "last word" in perfection of efficient design in the evolution of molariform teeth in man. But the main *deep* grooves or fissures, which in *permanent* teeth help to conserve some of the cusp edges from blunting attrition by their opponents, are almost absent and are hardly required in the more transient deciduous ones.

(*c*) Relatively to vertical length of crown, the depth or extent of *shearing overlap* of these deciduous molars is proportionately greater than it is in permanent molars.

Leaving now our close watch on the unit-by-unit assembling of what is truly the child's working model of the dental machine, we can suppose that with the arrival of the canines there has been set up a masticating apparatus that is complete and fit for efficient service during the next four years.* During those four years—if

* The quiescent interval between the eruption of one group and that of the next succeeding group is usually explained by the alleged need of a "rest," or recuperative period. In the case of the temporary teeth, at any

ever at all—have been acquired, and perfected by exercise, those complex co-ordinations of muscle effort that govern the normal free and rhythmical movements of mandible, cheek and tongue. Those varied but definite movements being acquired and well established in the musculature, what could be more favourable to a continuance of smooth and efficient working than that the next-arriving group of molar teeth should be of identically similar pattern? And so we find it to be, the permanent first upper molar even carrying the "mimicry" so far as almost invariably to bear a fifth cusp whenever that feature is present on the deciduous molar. I have handled several deciduous second upper molars each bearing a fifth cusp which in size and details of shape is exactly like each and every one of the other four cusps, and in it, as in the others, the grooves which flute out and sharpen the cutting edge encircle a well-formed rounded "umbicle" or tongue shield. This very exact duplication of crown-shape is doubtless in response to exactly identical environments, or to Lankester's "common action of evoking causes," and in this striking instance it is within our power to examine carefully such important factors as physical character of food and degree of its reduction, the habitual character of jaw movement and direction of thrust, and also the functional movements and re-acting influences of tongue, cheek, etc., as in part determining certain features in the form of the crown.

As to the premolars, I elsewhere described in full detail their forms and true occlusal relationship. And in the *Journal of Anatomy* paper, the important food-posing and food-holding function was shown to be demonstrated in a specially convincing way by the lingual cusp of *upper first premolars*, because the morsel or "work"-holding requirement is there the essential one during the upward-and-inward shearing thrust of the single-bladed lower first premolar (Fig. 6).

At the age of about 10 or 11 years there is what we might call a moderately "full mouth" of permanent teeth. The apparatus functions perfectly, notwithstanding that there has not yet been developed on the general morsal plane that upward sagittal curve which has for so long been miscalled the "compensating curve," in the mistaken and unfounded belief that its special function was, during incisive or protrusive movements, to provide balancing and strain-relieving contacts. The true interpretation of the sagittal curve at second and third molars is to be found simply in that rigid *economy of space* which Nature observes, and which is always associated with economy of effort and of material.

I venture to suggest that this Society is well fitted to deal with a current and long-held misconception in regard to the real conditions that exist in what I call the relationship of "*non-occlusal*" contact, this term serving to distinguish the condition quite clearly from the only other kind of inter-maxillary contact—*occlusal* contact. When from a position of normal occlusion the lower teeth are moved laterally in sliding contact with the upper teeth, the more extensive the total area of surfaces in continuous and

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rate, an equally good or additional explanation is the clear advantage conferred by allowing the child time to practice and acquire proficiency in the use of one new group before the next arrives.

simultaneous contact, the more nearly does the condition then approach what is *supposed* to be the normal or ideally-normal one. A skull with the full complement of sound, well-worn teeth is handled admiringly, and then, when the mandible is deflected laterally with all the convenient freedom allowed by the empty glenoid cavities, and the cheek teeth are made to slide in continuous and fine-fitting contact, the remark is often evoked: "How beautiful!" Certainly would the picture be a beautiful one if the prime function of teeth were but to *grind and deface one another*, and if the efficient comminution of food were a merely secondary function. I have here a number of plaster casts of sound dentitions that were as nearly normal as could be found. Each pair of casts has by a careful technique been immovably mounted in the exact relationship of inter-maxillary contact which existed in the living mouth when the lower jaw had been deflected in a lateral excursion. These and other intra-oral studies but confirm the conclusions I had reached a good many years ago. Put concisely, they are: First: The area of opposed tooth surfaces in actual contact at any instant attains its maximum amount only when in the one definite relationship of *occlusion*. Second: In moving in any direction away from this occlusal relationship, the area of possible simultaneous contact is progressively decreased, and tends towards the minimum amount. Third: In unworn or little worn dentitions the total area of the maximum intermaxillary contact attained in *occlusion* does not normally exceed three or four square mm. in amount, and in most of the laterally-deflected positions of the mandible the area of non-occlusal contact drops to a minimum which is restricted to contact between a single pair of opposed canines.

The supposed kinematic condition of extensive contact-areas does not normally exist, and but rarely exists in abnormal or in much-worn dentitions, where undoubtedly we are dealing with a faulty or a deteriorated apparatus. It should be quite obvious that any masticating work done between two opposed surfaces or edges must take place and be *quite finished before* those surfaces can come into contact with one another. In the working of any such machine, natural or man-made, the contact and attrition of the tool surfaces is not in itself an end or a functional aim, but is merely one of the unavoidable results of the constructive limitations and restraints imposed by mechanical or physical laws. And if anyone seeks for beauty in design, or a real instead of a fictitious cause for admiration, he will find it, not in Nature's supposed attempt to multiply contact areas, but in the wonderfully simple and effective arrangements by which useless contacts are avoided or kept down towards a minimum. The oblique direction of the condyle path, by which the moving mandible is compelled to come *downward* as well as forward, has normally the one essential function of throwing out of "mesh" and out of potential contact all the teeth except those that at any given instant are to act as the tools in that particular masticating thrust. It is so in a protrusive movement, when both condyles come downward to disengage the non-functioning cheek teeth from useless contact, and in order that the anterior teeth can operate freely in an incisive or a shearing thrust. So it is also in a lateral movement, when one condyle comes downward to throw the teeth on that non-functioning side out of contact and needless attrition. These remarkable "fine-adjustments" in

the physiological mechanism can be observed to be still acting for the conservation of effort and of tooth tissue even when, in a sound denture, the teeth have become much worn down. On the other hand, in some not uncommon abnormal conditions the vertical anterior overlap may be so excessive as altogether to prevent the cheek teeth from coming into effective shearing alignment; but that is another story, and outside present discussion.

Taking but one last glance at the completed normal denture of thirty-two teeth, it is well to observe that the anisognathism, or effective shearing "overhang," is just as definite at each and every one of the check teeth as it is at the anterior teeth.

I conclude by quoting the last paragraph from my paper to the Sixth International Dental Congress.—I have called that line (or curved surface) in which the external blades of all the maxillary teeth lie, "*the line of maximum shear.*" It is along that fixed line on the upper teeth that the external blades of the movable lower arm seek to deliver at any point a thrust of maximum shearing value. The highest masticating efficiency—and to that extent the good health—of the dental apparatus depends upon preservation of the functional integrity of that curved line. It is common knowledge that malocclusion or any breach in its integrity tends to encourage conditions that may become destructive, and that in some cases—and in different degrees by different people—are considered to be æsthetically objectionable. Yet it cannot be stated as a fact that the malposition of one or more teeth will inevitably or of necessity be followed by any or a single one of these inimical conditions. The *one thing* that does inevitably accompany any displacement of a tooth or teeth from the normal position is—that the shearing efficiency is in some degree depreciated, not always or necessarily at the displaced tooth, but unfailingly at *some* locus along the damaged "line of shear."

Discussion.

The President said the members had listened with interest to the paper which was somewhat difficult completely to follow, but the main principle, the question of shear, was one which was emphasised to a degree which would make an impression upon the members. It gave matter for thought even though many might believe that they had already thought about it. Mr. Shaw had certainly raised several points which would lead to considerable thinking. As those who had worked at the Royal Dental Hospital knew, Mr. Shaw was very keen indeed upon theoretical considerations, not necessarily those connected with prosthetic work alone. He had written a large number of papers and had put in a great deal of labour upon the various subjects. Probably the paper that evening was on a subject which was more dear to him than any other, and should be a subject of particular interest to Dr. Sim Wallace.

Dr. Sim Wallace said he was sorry he had no comments to make except to say that he had nothing but sheer admiration for the whole paper.

Mr. Pitts said that, as far as he understood it, Mr. Shaw's idea was that there was a definite correlation between the shape of the teeth and the function that had been assigned to them, and that the two had apparently evolved *pari passu*, so that, in theory at any rate, it ought to be possible to say that in any stage of the evolution of mammalian teeth a certain function attached to the particular form at any given time. That was getting into very deep waters in connection with evolution. If it was true it must be true for a great many

other parts of the body as well. Although there was an undoubted relation between form and function it did not always follow that the two evolved side by side. Sometimes it might be found that an entirely different function might become grafted on to some particular organ when it had appeared to outlive its usefulness. The pineal gland represented the rudiments of the third eye, but in man it was now one of the ductless glands with a specific function. There was also the suggestion that the neurenteric canal represented the primitive alimentary canal of invertebrates. In man function and form did not seem to have evolved side by side in that case, and it might be possible to find a good many other examples in anatomy. It seemed to him that a good deal of the proof of Mr. Shaw's paper must be obtained by a very close study of comparative anatomy. He certainly agreed with Mr. Shaw that the physiology of mastication had not been studied with sufficient care. Dr. Sim Wallace had added a great deal of knowledge on that point and shown how complicated it was. In a paper he himself had read some time ago, arguing from the shapes of the contact points of the deciduous teeth, he tried to imagine what the component movements of mastication were. He had always felt that probably in man the mastication or the various components of mastication developed very much at different periods of life. They might develop very considerably in different individuals. There might be perhaps several different forms all of which could be regarded as normal. Undoubtedly abnormal forms of mastication might rise quite early in life from premature loss of teeth. Mr. Shaw had made the point that the shear type of movement seemed to be very early evolved. He had been very interested to hear what Mr. Shaw had to say on the tubercle of Carabelli. Another writer had given an entirely different explanation, not based on function, but rather on form, and thought it represented a third characteristic of dentition, that mammalian dentition represented the fusion of two different elements and the tubercle of Carabelli represented the third. If Mr. Shaw's view was correct, that it had evolved in response to a definite function, it would be found to be very infrequent in primitive man and still more infrequent in the anthropoid apes, in which the masticatory function on the whole was much more efficient than in modern man, in whom the tubercle of Carabelli was very common.

Mr. George Northcroft said it seemed to be a little unfortunate that yet another term should be invented for a process supplanting words which were already in use. For instance, he could not see why the grinding action of the grindstone should be described as a shear; it might be that it helped to convey to some minds with greater accuracy the action which took place, but the term grinding had always been used and he did not see why the term shear should be introduced. He had a very fair picture of what Mr. Shaw meant by maximum shear of the teeth, but surely maximum shear was obtained in the carnivoræ and certainly not in man, who had a modified shearing action and not the perfected shearing action obtained in the seccateur action clearly shown on the first diagram. Mr. Shaw frankly admitted the possibility of man having had an edge to edge bite, which Prof. Keith was quite sure was so; it therefore seemed rather unwise to point out the beauty of the adaptation of the human dentition to the efficient maximum shear principle, when it must have been absent for about a million years. Our ancestors surely had as difficult feats of mastication as we perform to-day. They did not seem to suffer in the efficiency of their masticating apparatus because of the more marked absence of maximum shear.

Mr. Badcock admired immensely the patient enthusiasm with which Mr. Shaw had pursued his subject; perhaps it had a greater bearing on prosthetics than on orthodontics. Dental surgeons had appreciated what happened but not with the accuracy and minuteness which Mr. Shaw had pointed out the underlying features of the way in which human masticatory mechanism acted.

Mr. Harold Chapman said that perhaps the point of most orthodontic interest in the paper was that related to occlusion and shear combined. His own conception of occlusion was that shear operated by means of the buccal and lingual cusps, but Mr. Shaw had made it clear that shear operated by means of the buccal cusps more than the lingual cusps, which were also food-holding devices. Mr. Shaw had previously pointed out that the lingual cusps of the pre-molars did not occlude between the cusps of an upper and lower tooth, which perhaps would have given a shear action, but in the depression which was almost in the centre of the pre-molars. Mr. Friel had drawn some excellent diagrams showing that relationship as well as his conception of occlusion, and they would prove an interesting study in combination with the paper. Another interesting point was that when there was a very deep over-bite there was a great lack of shear action in the molar region. On the other hand, he rather gathered that Mr. Shaw's view was that shear operated before the teeth came into contact; he would like to know how much excessive over-bite there must be before the shearing action was rendered ineffective. He also wished to thank Mr. Shaw for the great work he had put into the subject.

Mr. Watkins said that considering the length of life of the permanent dentition, about sixty years, the attrition was not very great on the surface, which seemed to confirm Mr. Shaw's contention that the teeth did not rub on each other. They had been more or less taught in prosthetics that the teeth slid one on each other more or less to balance the bite, but it seemed to him that was not the case in natural dentition and that the food between the teeth kept the teeth apart except at the point where the teeth were being brought together to break the food into fragments.

Mr. Lindsay said he should imagine that while members might accept with great interest and gratitude Mr. Shaw's description of the mechanical action in connection with the comminution of food, they would be somewhat chary of accepting his deductions from the conditions he found in mammalian dentition to-day in connection with development. With regard to maximum shear, perhaps it was unfortunate, as Mr. Northcroft had said, to have to reform ideas as to what shear was, but he thought it might be taken that after all there was something more in the definition shear than mere cutting and that it comprised very largely not only cutting action but grinding and percussive action, and that it might be very accurately described as the actual mechanical force involved in mastication. He agreed with Mr. Northcroft that Mr. Shaw had got himself into a slight difficulty in his quarrel with the edge-to-edge bite, if he had to look upon the present condition as the latest developmental result of a long series of experiments on the part of Nature to produce the most efficient masticating apparatus. He noted that he discussed the question from the point of view of the present deciduous dentition. He did not know whether there was any historical or prehistorical data as to the nature of the deciduous dentition of man, and therefore he would suggest that Mr. Shaw was on rather dangerous ground in the majority of his deductions. For example, would it not be suggested that a very large amount of protection was afforded to the delicate gums by the ordinary masticatory influences of the mouth, the saliva and the action of the tongue and cheek and lips. It seemed a little dangerous to suggest, as he thought Mr. Shaw suggested, that the shapes of the teeth were necessarily evolved from the gum-protecting idea. The paper had a very definite orthodontic significance. It seemed to him the function of the Society now to maintain the maximum condition of efficient mastication. He could not entirely agree with Mr. Shaw that function was the sole care of Nature. After all, a man did not live by bread alone, and Nature occasionally went out of her way in order to produce beautiful effects.

Mr. Shaw said he was very gratified at the discussion, which was

better than he had hoped for. He was glad to think that Mr. Pitts believed there was something in the conception of maximum shear that was well worth following up. Mr. Northcroft had spoken of the use of the terms "shear" and "grinding." He had no intention of displacing the useful and handy word grinding, but when one came to apply one's knowledge of science, one realised that there was the science of mechanics which must be applicable to teeth and must to a certain extent be put forward just as it was and is put forward by all the great physicists and engineers. There was no difference of opinion as to the term grinding. Even the grinding of a pestle in a mortar was, with some substances, in its essence mainly a shear action. But his concept of "shear" applied correctly to all the different types of teeth.

Mr. NORTHCROFT said that that was triturating. He had only appealed for a correct use of terms. Johnson made it a great point in his papers that new terms should not be introduced, but terms should be used that had a definite meaning.

Mr. SHAW said although it might seem doubtful to Mr. Northcroft it was one of the things which he was very keen to bring about, a clear definition of terms and their meanings. In the front teeth most people agreed it was nearly a pure shear action and in the canines it was pretty much the same and largely so in the pre-molars. His conception of the use of the term shear, especially maximum shear, was in a short phrase to denote a *leading mechanical principle* that ran through a very large number of dentitions in animal forms. There seemed to be an idea that the edge-to-edge was superior to over-lapping. Why was not there the same desire to have this same edge-to-edge occlusion a little further back than the incisors or canines? Why not also with the pre-molars or molars? Mr. Chapman had referred to the analysis of the various functional elements of the pre-molars. In the paper it was said that there was shearing action on the buccal cusps, and the lingual cusps had as their prime function helping the tongue in food holding. As the teeth came together the food in the very small spaces would be subject to actions which he could not analyse. He did not indicate in his paper in any way that, in cases of malocclusion, shear action was abolished altogether, but that it was simply depreciated. There were plenty of cases in which such a thing could be seen if the jaws were examined at a position when just about passing in a masticating stroke. He had seen a good many cases where the pre-molars and molars, by a space of one-sixteenth of an inch, were prevented, when passing one another, from coming into contact at all.

The PRESIDENT, on behalf of the Society, thanked the author for his paper, and those who had taken part in the discussion.

A meeting of the Society was held at 11, Chandos Street, Cavendish Square, on Monday, November 5th, 1923. The President (Mr. WARWICK JAMES) occupied the chair.

Introduced to the President and formally admitted by him : Messrs. A. S. Ross, L. F. Fouraker, and L. H. Newbold.

The following paper was read by Mr. S. WILSON CHARLES,

MOVEMENTS OF THE TEETH FOLLOWING LOSS OF FIRST PERMANENT MOLAR.

THE changes which take place following loss of the first permanent molar may be divided into two main groups :—

(1) The first in which the first permanent molars and incisors only are in occlusion.

(2) The second in which the second molars or premolars, or both, are in occlusion.

These groups may be further sub-divided into classes which depend upon the number of molars lost, which may be anything from one to four, and they may be considered from three aspects :—

(1) With regard to the movements of the teeth in relation to one another.

(2) Changes in the relationship of the mandible and maxilla.

(3) Changes in the temporo mandibular joint and the bones of the face.

There are two important differences between these main groups. In the first group the force of occlusion is taken up entirely by the first permanent molars. In the second group this force is distributed over the permanent teeth which are in occlusion. The third difference is that the patient is usually younger, and consequently more susceptible from the point of view of growth to abnormal influences.

Time will only allow of the consideration of the first group, in which only the first molars and incisors are occluding. When one or two molars are lost upon one side of the mouth a condition is brought about somewhat similar to that produced upon animals in the experiments of Dr. Lawrence Baker, reported in the *International Journal of Orthodontia* for 1922. In these experiments young rabbits, sheep and dogs were used. The teeth on one side of the mouth were ground down until they were quite functionless, and the animals allowed to grow. At a later date *post mortem* examinations were made. The general results were :—

(1) Deflection of the longitudinal axis of the skull and general twisting of the bones. The articular surface of the temporal in the sheep, for example, was on a higher plane on the nonfunctioning side than on the other.

(2) Atrophy of the muscles of the non-functioning side.

(3) Changes in the temporo mandibular joint as shown by the difference in size of the condyles.

Baker neglects to state the actual changes which took place in the joint, and does not mention whether any changes took place in the internal structure of the bones. If the object of the experiment was to ascertain the degree of distortion produced by

mutilation, it has, in part, been attained. But if, as one gathers from reading the paper and the subsequent discussion, it was hoped to prove or disprove Wolfe's law, the results cannot be considered conclusive. Murk Jansen has pointed out the absurdity of attempting to apply an unproved law which applies solely to bones formed in cartilage to membranous bones. This distortion, if such a term can be applied, can be and is reproduced in man under similar conditions. Why it should happen is not so easy to explain as to demonstrate. A possible explanation may be found in an analysis of masticatory muscle action, especially if one holds the views brought forward by Keith and H. M. Johnson.

Briefly, as you know, their explanation is this: The group of muscles—masseter, temporal, int. pterygoid and ext. pterygoid, by their co-ordinated action depress and elevate the mandible. The so-called depressors, digastric, etc., and platysma, have nothing to do with the action, digastric and the hyoid muscles being solely concerned with the tongue. There is, as a result, a balanced action with little or no pressure at the condyle.

When under certain circumstances the teeth are mutilated, the co-ordinated balance is destroyed and abnormal pressure is developed at the condyle, with the resulting deformity or asymmetrical development. These remarks apply, though, in a lesser degree, even if the view is held that the mandible is depressed by the action of the so-called depressor muscles and that pressure is developed at the condyle. The following cases illustrate the changes which may take place in the position of the teeth in the relationship of the mandible to the maxilla and in the face when one or other of the first permanent molars have been lost by extraction or caries before the second permanent molars or premolars are in occlusion.

Case I.—A boy, aged 13, who at the age of 12 had the upper and lower teeth in perfect occlusion and absolutely free from caries with the exception of a small cavity in $\underline{6}|$ This tooth was removed while on a holiday, and the models show the present condition. The lower has contracted in the molar and bicuspid region and has moved bodily to the normal or working side, so that when the upper and lower molars are in occlusion, the centre between the lower incisors is towards the left and only the tips of the premolars meet on the non-working side. The maxilla has obviously twisted, the face being well developed upon the working side and poorly developed on the other, while the chin is markedly inclined to the left. (*See illustrations*).

Case II.—Models of a girl of 14, whose $\overline{6}|$ was removed some years ago before the eruption of the second molars and premolars. In the lower the second molar has moved slightly forward and tilted. The second premolar has erupted in the position of the first molar and first premolar, canine and incisors have dropped back. Both arches are well developed in the molar region, but owing to the collapse of the lower arch there is a marked crowding of the anterior upper teeth. The $\underline{6.5.4.}|$ have moved slightly forward, and the $\underline{2}|$ backward, shutting out $\underline{3}|$ from the arch. As in the previous case, the right side having been rendered functionless, the mandible has swung to the working side, but in this case the first molars meet cusp to cusp, while the anterior teeth as far as

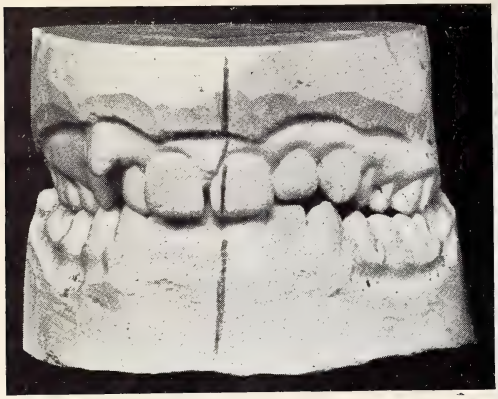
MOVEMENTS OF THE TEETH FOLLOWING LOSS OF THE FIRST PERMANENT MOLAR.

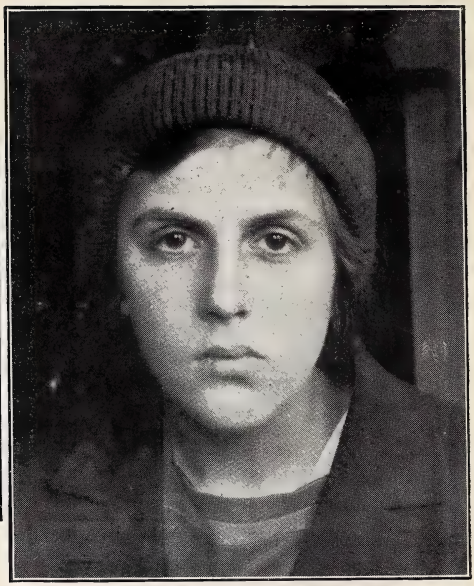
By S. Wilson Charles, L.D.S.

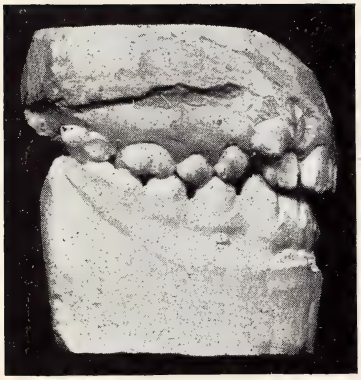
Case 1.

MOVEMENTS OF THE TEETH FOLLOWING LOSS OF THE FIRST PERMANENT MOLAR.

CASE 2.

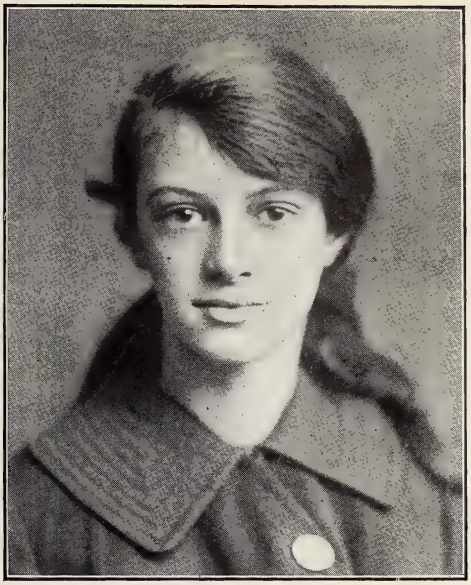


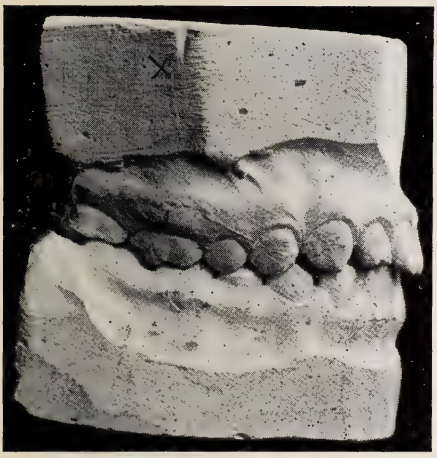


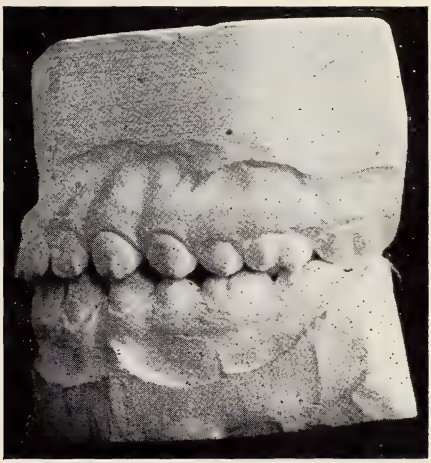


MOVEMENTS OF THE TEETH FOLLOWING LOSS OF THE FIRST PERMANENT MOLAR.

CASE 3.

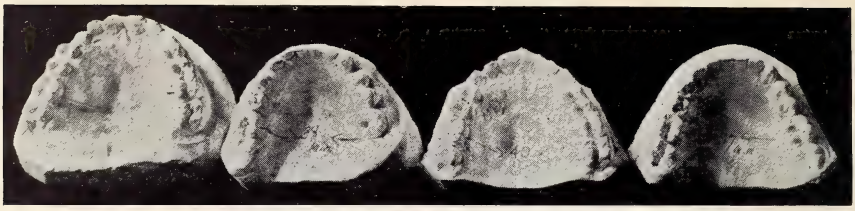




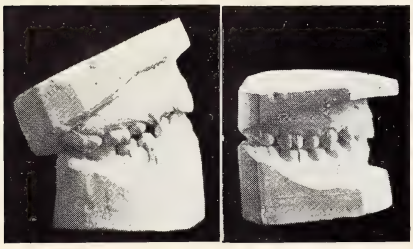


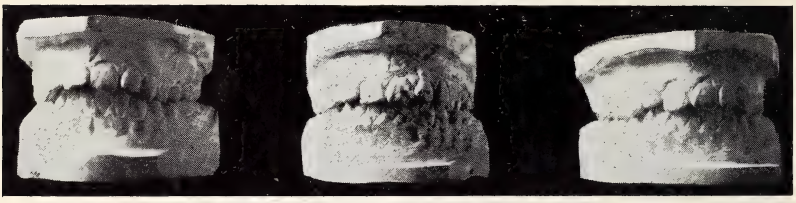
TWO UNUSUAL AND COMPLETED CASES.

By Mr. G. F. Cale Matthews, L.D.S.



Case 1. G. A., aged 12. Before treatment space between upper molars = 41 mm., lower molars = 38 mm. After treatment, 40 mm. and 37 mm., the correction of the distocclusion accommodating the width of the maxillæ.

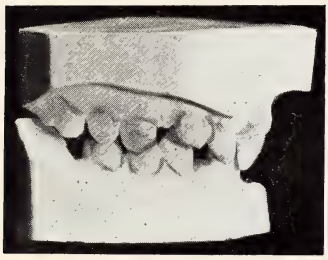




Case 2. Girl, aged 21.

A CASE OF MULTIPLE IMPACTION OF PERMANENT TEETH.

By Bertram Samuel, L.D.S.



the lower incisors are not in occlusion but outside the upper teeth. This is well shown in the photograph, the chin pointing to the left, with good development on that side and poor development on the other.

Case III.—A girl of 12. In this case the deciduous molars were removed three years ago, but the patient did not return as instructed for treatment of the carious permanent molars. The teeth were then in correct occlusion and were good with the exception of small occlusal cavities in $\overline{6}|6$. The right lower molar became very carious and collapsed, allowing the upper molar to come down until it bit upon the gum. The mandible has swung to the right side in this case, but the left side of the face is developed to a far greater extent than the right. The right side has been rendered functionless by the loss by caries of the $\overline{6},|$ and mastication has taken place upon the left side. The upper incisors have been pushed forward, and the teeth have erupted into what is apparently a well-developed arch. The appearance of the child is very noticeable, especially as the twisting is so marked owing to the greater development on the left side, while the chin points to the right. When the teeth are separated the mandible does not move vertically downwards, but swings to the left, so that when the teeth are separated about 2 mm., the centre between the upper and lower teeth corresponds.

The cases which I have shown illustrate the importance of the individual tooth to the natural denture. Excluding those cases where teeth have been removed to correct or prevent malocclusion, it is almost certain that the loss of the first permanent molar will be followed by a definite malocclusion of the remaining teeth whether erupted or not. There are of course many sides to the question; for example, neglect through ignorance on the part of the patient or refusal to take advice, but when one considers the thousands of mouths which are ruined year by year because one or two teeth have been, as it were, unthinkingly removed, it is not too much to suggest that at the least every effort should be made to minimise the possible evil results of this removal.

Discussion.

The President: We have had a very interesting paper on a subject which opens up a large discussion. There was a time when the extraction of the first permanent molar was thought to be an excellent method of treatment, and in my address from the Chair I remarked on the experience that one had as a student of the loss of these teeth and of the terrible disasters it leads to. Mr. Charles has gone over the ground very carefully and has given us a very interesting account of the subject.

Mr. J. W. Mayer: I have been greatly interested in the portraits of the patients shown by the author. I suppose one of the chief arguments in the case of an expansion is that if we extract any teeth the features of the individual are always altered, generally not to his benefit. The teeth generally extracted are the fours, but we are discussing the extraction of the sixes to-night. I cannot see why it was considered advisable to extract the sixes on one side. There are occasions when sixes have to be extracted. I suppose in this case there was no other treatment but extraction, but it seems to me that if you have got to extract sixes you certainly want to extract the whole four, and if you can extract them at about the age of eleven and a half you stand a very good chance of getting the second molars coming down

and filling up the places from which the sixes have been taken, with the result that there is a good healthy mouth. There is one feature with regard to the extraction of sixes which the author did not mention. In later life when the sixes have been extracted at such a time that the second molars have not come down and taken their places, you always get a tilting of the second molar with a very large pocket. There seems to be one ideal time to take out sixes, namely, between eleven and eleven and a half years of age. In that case there is the best chance of the second molars coming down and filling up the spaces.

Mr. CALE-MATTHEWS : I hope that the author will have the opportunity of following these cases through, and will show us at a later date what the results of the treatment which he has adopted may be, particularly what I may call the training treatment in the developing teeth. These three cases have been shown in such a simple and delightful way that one can understand the whole of what has happened from the start.

The PRESIDENT : The very frequent difficulty in cases of this kind is that the first permanent molars become carious and require extraction. I do not think we find caries to the same extent in cases where the arches are well developed, so that the complication of removing the first molars in a post-normal occlusion case is very much greater than it is where the arches are well developed. Mr. Mayer has expressed the opinion that the age of eleven to eleven and a half is the best age for removing the first molars, but the malposition of the other teeth is apt to be so marked and the bite so close that the second molars assume unfavourable positions, conditions which make one hesitate so much about removing the first molars.

Mr. E. N. COMMANDER : I myself am an example of the mischief which may follow the loss of the four six-year molars, and I have precisely the same trouble that Mr. Mayer has indicated. The other molars have not erupted normally. The extraction was done at the age of ten.

Mr. L. E. CLAREMONT : In two cases which came to me the upper first permanent molars only were removed and the position taken by the second was much more favourable than that which had been taken by the first. I am rather of the opinion that if one is going to divide and to remove one or two and not the four, it is preferable to remove the uppers rather than the lowers.

Mr. A. T. PITTS : There are still a number of people who advocate the removal of the first permanent molars as a routine treatment. It is a deplorable method of treatment in orthodontics, and it arose because the first permanent molars were so often carious. As regards selective extraction, it seems to me that the results of extracting the first permanent molars are in the majority of cases bad, and, therefore, I am not certain that one should increase the occlusion by taking out two sound molars on the left side if it is really necessary to take out the corresponding teeth on the right side. Is the distortion of the face a very serious matter ? The distortion was not very palpable in the photographs which the author showed, and although it is possible that the photographs did not show its full extent, in cases which I have seen the æsthetic appearance of the child was not markedly impaired. Therefore I would like to urge that if the first permanent molars have to be taken out only those which really require extraction should be removed. Although at one time I was an advocate of symmetrical extraction of deciduous teeth I have now come round to a different point of view, and in these days of widespread school dentistry I think it is very important that symmetrical extraction should not be too greatly encouraged.

Mr. H. G. WATKIN : I have a patient aged about twenty-five years who, when she was eight or nine, had the first permanent molar

removed, and it is almost impossible to tell now that they have been removed. By taking out the first permanent molars at an early age, apparently the second permanent molars have come forward in an improved position.

Mr. J. H. Badcock: I am shocked to hear that the extraction of four permanent molars as a routine treatment is still practised. I practised it myself freely at one time, and I have lived long enough to see the evil results which followed. The arguments for it were that the first molar decays more frequently than any other tooth in the head. One of the great evils of extracting the six-year old molars is the spacing which occurs. I saw a case only to-day in which the spaces between the teeth were just large enough to admit food and caused the patient a great deal of trouble and annoyance, and nothing could be done. With regard to symmetrical extraction, I agree that it is a mistake to extract two sound teeth on the left side because a similar extraction has to be made on the right; the shifting of the centre which occurs after unilateral extraction is usually the lesser evil. If a lower molar has to be removed and the patient is young, I believe it is better to remove the corresponding upper molar also even if sound. Although the result is a bad occlusion it is a better one than if one tooth only had been extracted. With regard to the age, there is no doubt whatever that to get the best result the extraction of a first molar should be done at as early an age as possible. If the extraction is made quite early the second molar does come forward in the bone and one gets cases where the occlusion is astonishingly good. Such cases are comparatively rare, but they do occur. If the tooth is badly decayed I think the age at which extraction should take place should be seven or eight.

Mr. S. Wilson Charles in reply: I should like to make it plain to Mr. Mayer that in these cases I did not extract the molars. These were cases which had been to a dentist before they came to me. I mentioned that the photographs shown did not really reveal the marked distortion that there was in these cases, especially in the second case, where the lower jaw was definitely swung over to the right and quite disfigured the face. In one of the other cases the lower lip was pushed forward on one side. I have hardly touched in the paper the question of all the results which may occur from the removal or loss of the first permanent molar; I have only desired to show the distortion which may take place as the result of the loss of these teeth.

Mr. A. L. Packham read

SOME THOUGHTS ON THE TEETH AND JAWS FROM AN ORTHODONTIC POINT OF VIEW.

It has been decided to devote this evening, the 5th of November (whether by accident or design, I know not), to papers read by those unfortunate members who have not done so before. I wish to thank Mr. Charles for his interesting paper, and to congratulate him upon emerging so gracefully from what is to me something of an ordeal. The remarks which follow are not novel, but it is hoped that they may be of some interest, as it is certain that each one of us views his subject, namely the teeth, from a slightly different angle.

The teeth are peculiar and important structures, and in many ways are set apart from the other tissues of the body. Metchnikoff divided all the body tissues into two classes; on the one hand those which, if damaged, are repaired, and in some cases replaced by a natural process, and on the other, those which are not so restored. The former class he called base tissues, and they included

those of mesoblastic and some of epiblastic origin; the latter he called noble, and they include two epiblastic tissues, namely the nerve cells of the central nervous system, and the teeth. Most epiblastic tissues grow, or are replaced, our hair is cut, and our nails are trimmed. Not so the teeth, and it appears, judging from Metchnikoff's classification, that they rank in importance with the most highly specialised cells of the body. Further, and as is well known, once the size and shape of the crown is determined within the body, it does not increase in size, nor alter in shape till death. It is difficult to conceive that growth does not take place in a nerve cell as age and stature advances, and therefore it may be said that in this aspect the teeth are in a complete class of their own.

Bearing in mind these facts about the teeth themselves, one might well anticipate that the structures supporting them should be, in a sense, special too. This we know to be the case, the presence of the alveolar bone is dependent upon that of the teeth, the fact becoming the clearer when we look at the skull of the manatee, in which the alveolus (in a dried specimen) is separate from the jawbone.

Seeing then that the masticatory apparatus is so specialised morphologically, one would expect to find that its physiological value is of a high order. It is a fact that a good and healthy set of teeth, together with undeformed jawbones, is one of the prime factors in the life and healthy activity of all animals in the wild state. There is no doubt that damage to a tooth, or to its supporting bone at once starts a train of events leading inevitably to disablement in the struggle for existence, and sooner or later to death. In civilised man, this scarcely applies, but we may note with interest that despite the demoralising influences under which the teeth find themselves, infection of the bone around them progresses very slowly as a rule, and an equal degree of infection in other bones of the body, which would probably set up a severe or crippling illness, is dealt with more or less successfully in the case of the mouth. One may say parenthetically that in the case of infection of the teeth themselves, the attack seems much too strong, and teeth decay quickly and almost hopelessly.

In view of these considerations, there would seem to be strong reasons to suppose that Nature has, in all probability, set up a specific and adequate protection against infection and other forms of harm to this extremely valuable dental apparatus.

So far as one can tell, little has been written from this point of view with regard to its action and efficiency. However, some of the factors which lessen its beneficial influence are recognised. Amongst these, deformities of the jaws (which are the special concern of the orthodontist) must play an important part. A type of deformity commonly met with in children in and around London, in hospital and private practice alike, is that in which the bite is too close, the condition being recognised by the excessive overlap of the incisor teeth. It is usually accompanied by an under development, and almost always by a backward position of the mandible. In the most marked cases, the lower incisors impinge on the cingulæ of the upper ones, or even upon the palate. The lower lip passes behind the upper incisor teeth, and the chin is receding. In these cases Mr. Warwick James has shown that mouth breathing can almost always be established as the prime factor in the etiology.

It is not difficult to see that such a condition of affairs must put the protective mechanism at a disadvantage, and that therefore orthodontic treatment is clearly indicated. But there is a lesser degree of this type of deformity which it is desired to bring before your notice. It would appear to be even more common than the one just described. It is frequently met with in adults, and in them passes as a rule without comment. Here the bite is simply too close. The articulation is somewhat, though not markedly, post-normal; the lips are well developed and meet easily over the teeth when the patient is in repose. There is considerable overlap but no secondary proclination of the upper incisor teeth, as in the more marked type described above. Although the articulation of the teeth is not normal, nevertheless the patient will declare that food can be chewed quite satisfactorily, and parents are not aware that there is anything wrong.

The etiology of these cases appears to be rather less easy to understand. Mouth breathing may still be the primary factor, accounting for the backward position of the mandible, and from that a restricted elevation of the upper and lower teeth respectively appears to follow. However, there are cases, especially in adults, where at any rate at the time of examination mouth breathing may be excluded, and it is these cases which are rather more puzzling. Another element, namely that of diminished and perverted functional activity would seem to arise. There can be little doubt that whenever the bite is too close, free and efficient mastication is rendered more and more difficult as the degree of closeness increases.

Although our patients tell us that they can chew their food satisfactorily, this action must be an abnormal one. Movement is restricted so that a mere up and down crushing effect is obtained instead of a grinding or shearing action which, as Mr. D. M. Shaw has recently indicated, is the most economical for the purpose in view. However, this relative ineffectiveness would appear to be met by the modern methods of presentation of food. It is, so to speak, semi-masticated for us. It may be therefore, that, in view of the diminished need for full functional activity of the dental apparatus, nature has provided a bite sufficient to those needs. It would seem that if young children, say between the ages of three and six years, were taught to use their teeth more vigorously than is usual in the present day, the mandible would be stimulated to take up a more normal forward position than it otherwise would do, and the closeness of the bite would disappear. Mr. Gladstone's famous doctrine of thirty-two chews to each mouthful, although originally directed towards the prevention of digestive troubles, may thus be considered as an excellent preventive for deformity of the jaws and sound advice from an orthodontic point of view.

In this connection one would like to draw your attention to an interesting paper written by Mr. Shaw, and published in the *Lancet* of August 23rd, 1919. In it he shows that the "mashing" of soft food by the tongue against the anterior portion of the palate, which often takes the place of proper mastication with modern children, must result in a pulling backward of the mandible by the action of the genio-hyo-glossus muscle. The same result is obtained when the anterior teeth (as opposed to the cheek teeth) are used to an abnormal extent. The tongue is thrown into action

in order to hold the morsel in position for shearing, and a backward pull on the mandible results.

Leaving the etiology aside, however, the question which it is desired to raise is this : Does this condition of, shall I say, simple close bite put our natural protective mechanism to such a definite disadvantage that steps should be taken to rectify it ? In other words, do these cases demand treatment ? It is a question which most of us have probably tried to answer at one time or another. The aim of all orthodontic treatment is to put the patient in the best possible condition so that infection in the mouth may be prevented, but we are acting in the dark unless we know how to align our treatment on the side of the defence.

There are many problems which it would be easier to deal with if we knew how Nature protects our mouths against disease. An inquiry into this defensive mechanism, its characteristics, and the methods by which it operates, especially in infancy and youth, and the conditions, both national and individual, which retard or advance its efficiency, although a very difficult one, might well prove as instructive as it would be interesting.

Discussion.

The President : This also is a very interesting paper. The point which the author has raised with regard to the action of the tongue muscles in pulling back the mandible is new to me and of very considerable interest. With regard to the first part of the paper in which the author speaks of Metchnikoff's classification of the tissues into noble and base, when one finds the teeth placed in the same category as the cells of the central nervous system one is inclined to smile, but, after all, the purposes which the teeth are required to serve in the animal make them second only in importance in the body to the reproductive organs. The teeth are necessary for the procuring of food, the protection of the animal, and so forth, and without teeth the animal of course will suffer in the struggle for existence. I was not aware of Metchnikoff's classification, but it is one of considerable interest and is perhaps flattering to the dentist.

Mr. Harold Chapman : I should like to congratulate the authors of both papers on their maiden efforts. I think the Society also is to be congratulated on having two of its younger members who have taken the subject so seriously, and I believe that I may speak for other members when I express the hope that we shall hear from them again before long. The point in Mr. Packham's paper that I would particularly like to refer to is the matter of the overbite, and I will leave out of consideration the genio-hyo-glossus and the matter of mouth breathing. The author has told us that the close bite or excessive overbite is the most frequent of all deviations from the normal as regards occlusion. I would have supposed narrowness of the arches to be the most frequent, and close bite the second. In a recent analysis of ten models of patients seen consecutively and for the first time, nine had excessive overbite, and I am inclined to think that that is about the average number. But I believe an even higher proportion of arches are too narrow, if the figures are based on cases which come for treatment. The treatment of narrow arches is simple compared with that of close bite. Upon the correction of the abnormality of close bite depends the correction of other co-existent abnormalities, therefore, from the point of view of treatment and degree of incidence, close bite may be considered the most important condition which the orthodontist has to correct. Of its etiology, in spite of what has been said, we know little or nothing definite. I put forward some suggestions in a paper which I read in 1921. There I propounded a functional

cause, and I have not read any criticism which put that suggestion out of court. One criticism—not a direct criticism—has recently appeared in a book entitled "Malocclusion of the teeth regarded as a problem of the apical base," by Lundstrom of Stockholm. Among these cases of post-normal occlusion or excessive overbite it is not rare to find a few in which the shape of the arch of the apical base is correct in the lower jaw, the upper apical base presenting some abnormality, and from this Lundstrom argues that function cannot be a cause of the associated abnormalities, but he passes over the fact that whilst the apical base may be normal in size and shape its position in the apical plane may be abnormal. In other words, a normally-shaped lower arch may be a victim of post-normal occlusion. Abnormal function may have produced some correlated effect in another part of the mandible (to compensate for the normally shaped apical base), which, whilst not the apical base, is very closely associated with it. Therefore, I am of opinion that whilst a study of the apical base is of inestimable value, it must not be divorced from the "developmental defects of bone" of Bennett's classification or from the "masticatory face" of Keith and Campion. I would heartily commend the study of this little volume to anyone interested in the etiology of malocclusion. It is an analysis of the views put forward in Europe and America from time to time and the author's deductions therefrom.

From a study of the features, the jaws, and the occlusion in these cases it would seem that the abnormality is a lack of vertical development in the molar region, but there is also the post-normal position of the lower arch of teeth to be taken into consideration, and it is possible that the latter accentuates the appearance of the former. The latter may be due to a shortening of the antero-posterior width of the ascending ramus. If this premiss is correct, treatment should be undertaken with the object of increasing the vertical development of the mandible as well as of bringing it forward. It is well known that a bite plate effects a satisfactory change in a sufficient number of cases to more than justify the treatment. But what the change is and how it is brought about we have no more knowledge than we have of the cause of the condition.

The author has hinted that it is a matter urgently calling for investigation, and I hope that this Society will foster and encourage such an investigation. I believe that if it were to offer a prize for the elucidation of a problem such as this the result would be greatly to increase the common knowledge and with that to increase the benefit of the treatment given to patients. The author also referred to the stimulating use of the jaws between the ages of three and six. I have expressed the same opinion here on more than one occasion, but I would suggest that the age of six is too late. These abnormalities are to be seen in full force at three years of age if only we could recognise them.

Mr. S. Friel: I feel somewhat puzzled about the author's drawing of the tongue. Recently I have been making dynamometric observations upon the tongue wherein the tongue pushes upwards and forwards on the instrument in the same direction as in the author's drawing. In the first twelve cases where the maximum pressure was over 4 lbs. the majority of those cases did not show a marked overlap. Those children who had a tongue pressure under 2 lbs. had more overbite on the whole than the children with a tongue pressure of over 4 lbs.

Mr. B. B. Samuel: There is one point on which I join issue with Mr. Packham. I cannot agree with his statement that the "overbite" is the most common condition found. It is generally accepted, I think, that this condition is mostly met with in distal occlusion cases. It was noted by E. H. Angle as the result of some observations made in 1889 that out of a series of 1,000 cases some 87 per cent. were cases in which the dental arches were in what would now be called a normal relation. Therefore, if Mr. Packham's observation is correct the

conditions have rather changed since that time. I myself have always felt that this condition of distal occlusion has increased very much recently. One certainly sees amongst private cases an increasing number in which this condition obtains. But the statistics I have just quoted leave us only 13 per cent. of cases to include all conditions of arch mal-relation, and between these figures and the statement by Mr. Packham that this condition is the most common to be found there is a very wide difference.

Mr. A. T. Pitts: This paper introduces us to very fundamental problems. I must say that for myself I find it extremely difficult to determine what should be regarded as overbite. It seems to me that one speaks of normal bite in a somewhat arbitrary fashion. The greatest amount of variation has been found to occur in the relationship of the upper and lower incisors. It seems to me that perhaps some of the cases that are termed overbite may really represent only a rather excessive degree of variation, still within the limits of the normal. If we accept Keith's view that the relationship of the upper and lower jaw is changing perhaps we could believe that the relationship of the upper and lower incisors would show a greater degree of relativity. One does see cases in which post-normal occlusion is quite well marked and which do not seem to call for any treatment. A point for consideration in determining treatment is whether the jaw appears markedly diminished in size so as to give a weak expression to the face. One does see cases in which the teeth are worn down as a result of the action of the incisors, and it is difficult to think that that extreme wearing down can be caused by an up and down movement only. The whole series of problems require to be elucidated in this connection. But at present I find it difficult to get a grasp of the conditions which might really be termed overbite.

Mr. H. G. Watkin: One possible cause of overbite may be the introduction of knives and forks. We cut food up and put it into the mouth in a way which does not call for the use of the incisors but gives the molars all the work to do. If, when young, we had to bite food, that would prevent the over-eruption of the incisors and consequent overbite. I have seen numbers of cases of overbite where the lower incisors actually ulcerated the hard palate. In those cases it is quite necessary to undertake treatment.

The President: One would say that the incisors should be more or less vertically placed in order to be normal. There are certain people who have a more primitive type of jaw. My own incisors, for instance, bite practically edge to edge, but I think that those cases in which the cingula of the maxillary incisors articulate with edges of the lower incisors might be regarded as cases of normal occlusion.

Mr. Steadman: In the drawing shown by the author I am not quite sure that I agree that the position of the tongue is normal. I think that the tongue is a very much larger organ than is shown there, and the mass of the tongue would tend to keep the mandible in its proper situation.

Mr. A. L. Packham, in reply, said: The diagrams shown with my paper are not original. They were all worked out by Mr. D. M. Shaw in his paper from which I quoted and which appeals to me as being most interesting. This question of the large tongue is fully treated in that paper and I commend it to your notice. When the point of the tongue is used for mashing food against the anterior part of the hard palate the genio-hyo-glossus muscle is contracted. The direction of the force is an upward and forward one. There is now a tendency for the origin and insertion of this muscle to be reversed, and as a result of this (the filter being fastened to the genial tubercles of the mandible) the jaw is pulled backwards. Mr. Shaw in his paper says that he has worked this out by actually feeling inside the mouth in cases in which premolars have been lost, and he has felt the tonic contraction of

these muscular fibres. He also quotes the cases in which the symphysis of the mandible has been removed by operation, and in these it is a fact that the patients cannot push forward with their tongue at all, rather supporting the idea that when the tongue pushes in this direction the mandible attached is pulled back. I cannot exactly join issue with Mr. Samuel as to the relative frequency of this close bite and the post-normal occlusion. I am simply stating what I have observed. I am not enough of an engineer to answer Mr. Pitts fully as to whether a close bite does or does not restrict effective mastication of food, but I believe Mr. Shaw holds that it does do so, and this view appeals to me as being probably correct. It appeals to me as reasonable that, as the two jaws come closer and closer together mastication is proportionately less and less efficient. When all the teeth are taken out and dentures are made it is nearly always the case that the dentist is apt to allow the bite to come slightly more close than normal, the patients thus being made more comfortable, partly, I believe, because they do not bite as well. When the dentures are made, say two years after extraction, one can quite happily open the bite. I believe this tends to increase the efficiency of the artificial teeth.

Casual Communications.

Mr. S. Friel : I have to bring before the Society a case which I have been treating for a good many years, and which I thought had been successful so far as success was possible ; but a very unpleasant complication has arisen, whether due to my treatment or not I cannot say. The case was one in which the spaces for the canines were closed, and I opened up those spaces, but now the second molars are coming down impacted, especially the lowers. This case also possesses an interest because the two upper second premolars have erupted completely rotated. The age of the patient is now twelve or thirteen. (X-ray photographs and models were shown in the epidiascope.)

Mr. G. Northcroft : I showed a somewhat similar case to this a few years ago. My case was perhaps a little different in that there was a delayed eruption of the second molars, and at the time the X-ray photograph was taken the third molars were shown very high up, and there was an obvious tendency towards gross impaction of these teeth unless something was done to relieve the crowding. Although it seemed a drastic treatment at the time, the second molars were removed, and the wisdom teeth have since grown down in a very good position. The patient was sixteen years old at that time, and she is now, I think, twenty-two. I was extremely interested in the second complication in Mr. Friel's case, and should be very grateful to Mr. Friel if he can suggest any cause for that rotation of the second premolars. I have had similar cases myself, which have always puzzled me extremely. I cannot conceive why they should occur, and it seems to happen too frequently to be merely a " sport."

Mr. A. T. Pitts : I should like to ask the author if there was any history of the deciduous predecessors having been extracted or becoming carious. I have often thought the rotation might be due to some previous injury caused either by caries or extraction of a deciduous predecessor. Another interesting point, quite apart from the communication, is that it would be exceedingly instructive if our Society could get together a museum of what I may call, without any disrespect to Mr. Friel, orthodontic failures. It would be very useful to have such records kept.

Mr. J. H. Badcock : The two points in this communication, the impaction of the molars and the rotation of the premolars, are very interesting. I do not think we know very much about the causation of the prone position which we so often see in wisdom teeth and occasionally in second molars, and quite rarely in first molars. I had a case

where the first molars were impacted underneath the second temporary molars, with the result that they were unable to erupt and eventually the posterior cusps came through when the patient was about twelve years of age, in much the same way that wisdom teeth often erupt by their posterior cusps only. I extracted the temporary teeth and was able to tilt back the molars, and they are now in good position. With regard to rotation, I have a few cases where the teeth were rotated through a half circle, but I have come to the conclusion that a certain amount of rotation of premolars very commonly follows expansion, whether *post hoc* or *propter hoc* I cannot say, but it has often occurred to me, after expanding the temporary teeth to find the premolars erupt more or less rotated. This has happened so often that I think it must be a case of cause and effect. My expansions are usually done by means of plates, but if the expansion were by any other method I do not think it would make much difference. It may be that as the temporary teeth are moved outwards the relation of their roots to the crowns of the permanent teeth lying between them is altered so that a rotating action is set up.

Mr. S. F. St. J. Steadman : I should like to ask the author if his treatment has moved back the six-year old molars. The X-ray pictures seemed to show that the second molars have impinged upon and done some damage to the first molars. I should be inclined to remove all the four second molars. The operation is a simple one, and I think that if it were carried out the third molars would come down with normal occlusion.

Mr. Harold Chapman : I have had the opportunity of seeing the X-ray picture of this case, and it does not seem possible that any orthodontic treatment could have pushed the second lower permanent molars into the almost horizontal position in which they are, with the crowns forward. If the orthodontic treatment had done anything, surely it would have pushed the crowns distally.

Mr. Friel : I am afraid I have no theory for the rotation of the premolars. There was a considerable amount of caries in this mouth, and it had been there for a long time. I think the rotation of the premolars probably has increased that caries because it has made such a long contact point, indeed, it is no longer a point but a surface. There are two long flat surfaces together. Mr. Badcock's explanation of rotation seemed quite possible. I have never seen a case before so completely rotated. I do not think that the treatment which was adopted could have moved back the molars. When I want to push back molars I find it exceedingly difficult to do so. I doubt whether I could have pushed back the molars very much. With regard to the narrowness of the arch, I have had the arch very much broader, but it collapsed, and whether the rotation of the premolars has helped that or whether there was some other circumstance beyond my control I do not know.

The Annual General Meeting was held on Monday, December 3rd, 1923. Mr. G. S. Cale-Matthews in the chair.

The Chairman read a letter from Mr. Warwick James, the President, regretting his inability to be present, and saying how sorry he was to miss Professor Thomson's lecture.

Professor Arthur Thomson, of Oxford, read his paper on " Facial Development " to a deeply interested audience.

There was no discussion owing to the lateness of the hour, but the hope was expressed that Professor Thomson would give the members another evening in the following session, when a discussion could take place.

FACIAL DEVELOPMENT.*

By Professor ARTHUR THOMSON.

Dr. Lee's Professor of Anatomy, University of Oxford.

I WISH, in the first instance, to express my appreciation of the compliment you have paid me by inviting me to address you on Facial Development. I gathered, from the reply of the Secretary, that I was selected to speak on this particular subject because, by accident, I happen to be the Professor of Anatomy at the Royal Academy. I confess that I do not altogether see the connection. I am more interested in the subject from a scientific than from an æsthetic point of view. It is rather to the scientific aspect of the question that I wish to direct my remarks to-night, particularly to that side of the subject which is now usually described as mechanistic, but which I, for my part, would prefer to regard as the reaction of structure to function. Of course, any attempt to deal in detail with the subject would involve a much longer time than is at my disposal, yet, for the sake of the development of the argument, it is necessary that I should draw your attention to certain matters with which you are doubtless already well acquainted. In dealing with this question, I am afraid some of my opinions may appear unorthodox. However, I am prepared to submit them to the test of your critical faculties, knowing full well that there is no Society more competent than your own to deal with my arguments. The more one goes into the question the more one realises that it always resolves itself ultimately into the question of teeth.

I will first direct your attention to the mesial longitudinal sections of three skulls, Fig. 1, the first that of a man, the second a chimpanzee and the third a gorilla. The figure represents the skulls oriented on a common base of the *same length*, corresponding to the cranio-facial axis disposed at an angle of 27° to the horizontal. My reason for drawing your attention to these sections is because it is necessary to have some common standard of comparison between the types with which we have to deal. We may take the cranio-facial axis as marking off the two parts of the skull, viz. that which is cerebral, from that which is facial. If we can find a common meeting ground on this cranio-facial axis, then, it seems to me, there is reason for drawing a comparison between the different types based upon such a common base line. With respect to man, I would suggest that, as between individuals and races, it is most important that we should have a plane of common comparison, such a plane as may be oriented in a particular way, and then we will be able to realise what grows out above and behind it, and what grows down below and in front of it, or, in other words, what it owes to cerebral

* Proceedings of the British Society for the Study of Orthodontics.

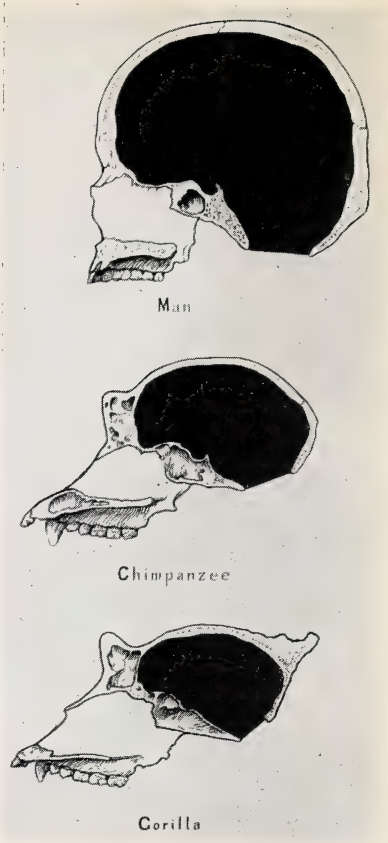


FIG. 1.—Mesial longitudinal sections of the skulls of a man, a chimpanzee and a gorilla, oriented on a cranio-facial axis of the *same length*, disposed at an angle of 27° to the horizontal. The diagram illustrates the *relative* proportions of the facial and cranial parts of the skulls when reduced to a common base line of the same length.

expansion on the one hand, and facial protrusion on the other. A distinguished Dutch professor of the Eighteenth Century, Peter Camper by name, first drew attention to this matter, and utilised the cranio-facial axis as the base line of comparison. There have been numerous other attempts to orient the human skull on a common base line, but these are, if I may say so, artificial and not morphological. As a result of many experiments I have come to the conclusion that, if this cranio-facial axis be disposed in relation to the horizontal plane at an angle of 27°, then we have, so far as it affects man, a morphological ground of comparison. In the gorilla and in the orang, you will note how the muzzle or facial part of the skull preponderates in size over the cerebral envelope. In man, on the other hand, you will find an enormous development of the brain case and a reduction in the size of the facial skeleton, the facial triangle denoted by the lines associated with the name of the late Sir William Flower, who was the first to point out the enormous importance of the size of the teeth, in respect of the varieties of mankind. He made use of the teeth to group mankind into the big-toothed variety, the middle-sized toothed variety, and the small-toothed variety.

In my next illustration (Fig. 2), in which the method of orienting the cranio-facial axis at an angle of 27° with the horizontal has been

adopted, we have the outline of three skulls superposed. The three types represented comprise a British, an Australian and a Negro (Malay) skull. You will see how varied the form and development of each of them is. In one, the British, the form is determined by the brain at the expense of the face. In the Australian, the muzzle is large and the calvaria small. In the Negro, there is a well-developed muzzle associated with a brain case of fair average capacity. I am assuming that you are familiar with all these facts, but it is necessary for me just to point out their connection with what I have presently to say.

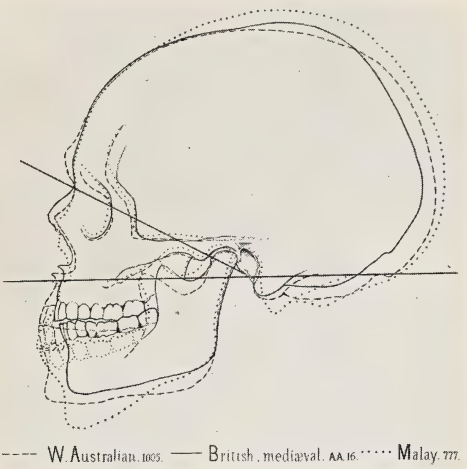


FIG. 2.—The outlines of a British, an Australian and a Negroid skull superposed on a cranio-facial axis of the same length, disposed at an angle of 27° to the horizontal. Note the relative size of the teeth and mandibles.

Taking now another skull (Fig. 3A)—a mediæval British skull, you will see that the teeth are all present except the last upper

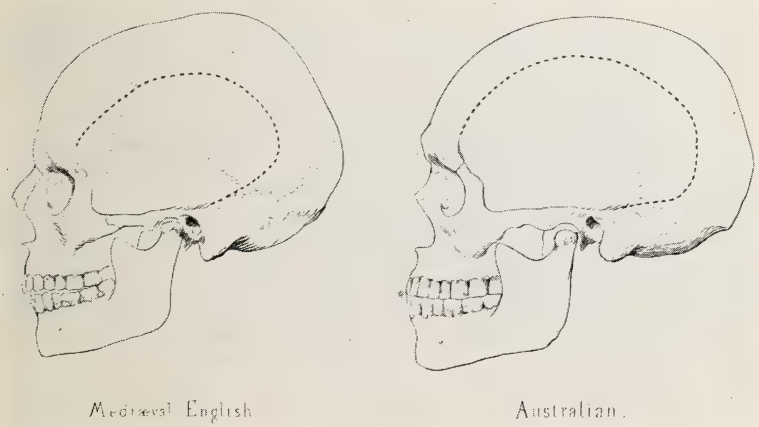


FIG. 3.—Diagram illustrating how the Australian skull with the bigger teeth and more powerful mandible exhibits a larger area for the origin of the temporal muscle (represented by the dotted outline) than is displayed by the British skull, which has smaller teeth and a less strongly developed mandible. The examples chosen are average and not extreme types.

molars. Note particularly in this instance the area of attachment of the temporal muscle. The next illustration (Fig. 3B) exhibits an Australian skull with much larger teeth and a heavier mandible. Obviously, to move such a jaw, a much more powerfully developed temporal muscle was required, consequently the area of attachment of the muscle, as displayed on the skull, is much greater in this case than in the mediæval specimen. Further investigation proves that, as a general rule, the bigger the teeth, and the heavier the jaw, the more pronounced will be the development of the temporal muscle, whereas in people with smaller teeth, the musculature of the mandible will be less powerfully developed.

In the next illustration (Fig. 4) fifteen mandibles are shown,

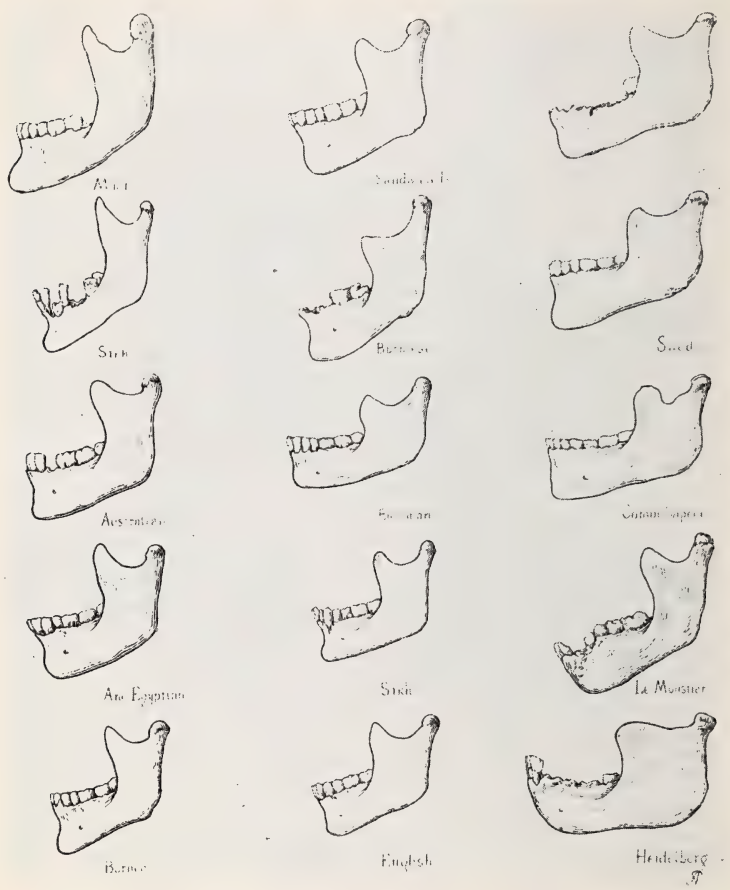


FIG. 4.—The figure illustrates the variety of form displayed by the human mandible. The specimens selected possessed, at the time of death, most if not all their teeth. Note the varying breadth and height of the ascending ramus, the upstanding nature of the coronoid process in some instances, and the varying splay of the gonial angle. The specimens are represented in what is assumed to be their normal position when the skull is oriented with the cranio-facial axis disposed at an angle of 27° to the horizontal. (See Fig. 5.)

all of which at the time of death, had their full complement of teeth. You will notice that these jaws have been placed in a somewhat unusual position. In most of the text-books the mandible is usually represented as placed with the lower border of the body or horizontal ramus in a horizontal position, and the posterior edge of the ascending ramus is allowed, so to speak, to select its own slope. My reason for orienting the inferior maxilla in the way indicated in the diagram, is to show, as you will see presently, that the posterior edge of the ascending ramus is more constant in position than is the lower border of the horizontal ramus, for the former more nearly approaches the vertical than does the latter the horizontal. You will be struck by the differences displayed in these various mandibles. There is a cast of the mandible of the most ancient fossil man yet known, the Mauer or Heidelberg jaw. Note its massive construction and very broad and low ascending ramus. This series of illustrations has been arranged so as to show the varying width of the ascending ramus. You will notice that it gradually becomes narrower in the process of evolution from the lower to the more civilised type. But this collection of jaws also reveals the fact that the ascending ramus in the series is becoming more elongated. A further point is that whilst in the oldest jaw of which we have any knowledge, the coronoid process is low and stunted, as we pass upwards in the series this process exhibits considerable variation in respect of its height or length. In this connection I may be permitted to remind you of certain facts with regard to the methods which Nature adopts in the application and production of force generated by a muscle. If two muscles be taken, each having the same number of fibres, the longer the fibres are, the slower will be the contraction of the muscle, and the more powerful its action. If the muscle fibres be shortened, the muscle acts more quickly, and that increase in speed is gained at a sacrifice of power. Nature, in the case of the temporal muscle, adapts the muscle to the immediate requirements of the case. In the big-toothed varieties of man, where the food is coarse and rough and requires a powerful apparatus to chew it, we recognise the advantage of a low coronoid and a broad ascending ramus, the former associated with a lengthening of the fibres of the temporal muscle, whilst the latter affords the benefit of increased lever action. As you ascend the scale, and the teeth are reduced in size, probably as the result of artificial means of softening the food, such as by cooking, you get the ramus narrower and the coronoid process more pointed.

These variations in the length of the different parts of the jaw result in differences in the splay of the angle. Viewed from the standpoint of the teaching laid down in the text-books, there is considerable confusion in respect of this matter. It is constantly asserted that the angle opens with advancing years, and too little emphasis is laid on the fact that the changes are largely induced by the shedding of the teeth. In this instance, however, I want you to notice, that in all these specimens, the teeth are either all present, or were all present at the time of death, and yet you see there is a remarkable variation in the appearance of the angle of the mandible. I would value the assistance of those of you who are immediately associated with the practice of dentistry in the elucidation of one interesting point. Supposing that a man or woman, in their prime—say from 25 to 30 years of age—is provided

with a complete denture, both upper and lower, it would be extremely interesting to know what changes take place in the angle of the jaw by the time they reach the age of 70, making due allowance, of course, for the absorption of the alveolar border, and taking every possible care to avoid any sources of error.

I next show you (Fig. 5) a composite picture of the outlines of twenty skulls of various types and races, oriented on the common base line of the cranio-facial axis. It is a remarkable thing, that the posterior borders of nearly all the ascending rami of the mandibles of these skulls, for the space of an inch or so, are disposed almost vertically in the same plane. I have not yet had an opportunity of analysing these observations very carefully, but it is a striking fact that the lines of all these superposed mandibles, at this point—the back of the ramus—are almost identical. On the other hand, if we take the lower border of the horizontal ramus of the mandible, we note a remarkable range of variation in its

FIG. 5.—A composite figure composed of the outlines of 15 skulls oriented on the cranio-facial axis disposed at an angle of 27° with the horizontal. In this instance note that the cranio-facial length of each individual skull is represented. The angle between the two lines, viz. the cranio-facial axis and the horizontal, closely approximating to the position of the basion, is taken as the fixed point. As will be seen, the outlines of the majority of the posterior borders of the ascending rami of the mandibles display a nearly vertical direction. The composite comprises the following skulls: African Negro, Roman, British, Negro, Chinese, Sandwich Islander, Zulu, Javanese, Maori, Dane, South Australian, Turk, Russian, Bushman, and Anglo-Saxon.

disposition. When one comes to think about this, one appreciates that there is a physiological reason for it, because if we were to adjust these mandibles to a base line determined by the mean and extremes of the positions occupied by the lower mandibular borders, we would have as a result a condition in which, in some instances, the mouth could not be opened.

I wish next to refer, for a moment, to the lengthening of the coronoid process, a condition necessarily associated with a shortening of the fibres of the temporal muscle. Here I must take the opportunity of directing your attention to the fact that in dealing with the senses, as related to facial development, we have to remember that the tongue, in which the sense of taste is located, is also directly associated with movements of the mandible during mastication. I venture to think, however, that due consideration has not been given to the fact that, as we speak, the mandible is in a constant state of flicker, the movements being very slight and very rapid. A consideration of these facts led me to inquire further into the

mechanism of the mandible, and I realised that a factor of such importance as the determination of the centre of gravity of the jaw has been almost entirely overlooked. I have devised a piece of apparatus by which I am endeavouring to record the varying position of the centre of gravity of the jaw, and so draw certain deductions, but unfortunately I have not had the time at my disposal to complete the record or to provide you with any particular results. But I want you to notice that by adopting the ordinary methods used to determine the centre of gravity, I can place the jaw in a position of equipoise, and when it is thus balanced, you will find that the posterior border of the ascending ramus is almost in the same position as that indicated in the illustration I have just shown you. Ordinarily we are unconscious of the fact that some slight muscular effort is required to keep the jaws closed. It is only at death, or in unconsciousness, that the mandible drops, thereby indicating that the slightly heavier part lies in front of the centre of gravity, which is usually situated at the middle of a transverse line passing through the interval between the first and second molar teeth. You will realise that if the mandible in nature be so balanced, the muscular effort necessary to produce the slight tremulous flickering movements which are associated with the enunciation of speech, while they entail but a very slight amount of muscular effort, do necessitate that such action should be rapid and prompt. I venture to suggest, therefore, that this development of the coronoid process, as displayed in different groups of mankind, is intimately associated with the elaboration of a more complicated system of speech. Whereas in fossil man, and possibly in the humbler types of mankind now existing, the great essential was power to crush the food, we, by the adoption of cooking, have been able to attain the same end with the expenditure of less power, whilst, as speech has been developed and become more complicated, the necessity for more rapid, if less powerful, action has become developed.*

There is another detail the importance of which I do not think has been sufficiently realised in this connection. Here again, you are familiar with the description given in the various text-books of the movements of the mandible at the temporo-maxillary articulation—a glide combined with a hinge movement. Great stress is laid upon the importance of this in diminishing strain of any sort on the inferior dental nerve as it passes into the inferior dental canal. That, no doubt, is one advantage, but there is another that has been overlooked. By the combined movements at the temporo-maxillary joint, the coronoid process and the insertion of the temporal muscle are always kept in line with the direct pull of the muscle, to the direct advantage of the action of the muscle.

What I have said in respect of the temporal muscle and the lengthening or shortening of its fibres applies with equal force to the masseter muscle, but the time at my disposal is insufficient to enable me to enter into this aspect of the question. I would remind you of what is pointed out very clearly by Tomes, that there is an inverse ratio between the development of the temporal and

* Possibly the elongated and recurved coronoid process in the mandible of the Herbivora may be accounted for in much the same way, only here the action is concerned with the rapid movements involved in nibbling the pasture on which the animal feeds.

the masseter muscles. Thus, in cases where the temporal muscle is great in bulk, the masseter is reduced in mass, whereas, when the temporal is small, a large masseter is met with.

Turning to another aspect of the subject, I would like to remind you of certain features in connection with the architecture of the superior maxilla. The two superior maxillæ are united by a median suture. The arrangement of the hard palate and the alveolar borders is not unlike that of an apse; it will be noticed that the apse is buttressed up posteriorly and thus prevented from slipping backwards, by the outstanding processes which are familiar to you as the pterygoid processes of the sphenoid bone. It is these which prevent the backward thrust of the maxilla when subjected to blows from the front. These pterygoid processes may be described as forming the internal buttresses of the superior maxilla just as do the zygomatic arches externally. When we come to examine the pterygoid plates—and they, be it remembered, are developed in membrane—it is interesting to note that very remarkable differences are to be observed in the expansion of these processes in different individuals. My attention was first directed to this when examining a series of Eskimo skulls. In studying the effect of muscular action, one must always bear in mind the fact that a muscle having two attachments will exercise its traction effect on both its areas of attachment, at what we call its origin, as well as at its insertion, and under certain conditions, the action may be reversed. In nature we have many examples of the reversed action of a muscle, where the so-called origins and insertions may alternately react to the contraction of the muscle. In the Eskimo we have a very interesting demonstration of how the external pterygoid plate reacts to the strain imposed upon it by the action of the external pterygoid muscle. The Eskimo have particularly large external pterygoid plates, which indicates that the external pterygoid muscles are powerfully developed. As a result, when you examine these processes with care you will notice that their relations to other parts of the cranial base are somewhat disturbed. Under ordinary circumstances, when you examine a skull in the *norma lateralis*, you cannot see the foramen ovale, which lies so horizontally that it escapes the eye. But in the majority of Eskimo skulls, when so examined, the foramen ovale is clearly visible. We can only account for this by assuming that the pterygoid muscles are so developed in this particular type of skull that they exercise a traction effect upon the surfaces of bone from which they arise, and pull them slightly outwards and downwards, so that the foramen ovale, in place of being horizontally disposed, as is usual, is oblique in position, and therefore is better seen. At the time I studied these skulls—a good many years ago—I was not in a position to offer any explanation of the condition, but subsequently it came to my knowledge that these people habitually employ their leisure, if I can so describe it, in chewing the hides from which they make many of their domestic articles. Men and women, when they have nothing better to do in the long winter night, are constantly chewing and grinding these hides so as to soften them, and render them suitable for the purposes for which they are intended. This is borne out by the particular conformation of the temporo-mandibular joint, and also by the way in which the teeth are ground down. Into this subject Sir Francis Knowles, then my assistant, made an inquiry which I suggested to him, and

in his paper he dealt with the peculiarities met with in the joint surfaces. It is to this expansion of the external pterygoid plate that I now wish to draw your attention, as proving how such a muscle as the external pterygoid, whilst causing a movement of the mandible on the one hand, may on the other react on the form of the cranial bones from which it derives its origin.

In the arrangement of its parts the superior maxilla is a wonderful bone. The thinness of its walls is quite unusual, and yet it resists the pressure to which it is subjected in a manner quite astonishing.

The antrum is one of its features about which we know very little except perhaps the obvious suggestion that its presence helps to lighten the bone. We do know that, in man, the antrum appears to have, as Sir Arthur Keith has shown, an intimate association with the eruption of the molar teeth of the upper jaw. I venture to suggest that possibly the molar teeth have more to do with the expansion of the antrum than the antrum has to do with the eruption of the molar teeth. It may be that the truth lies between the two. But my reason for taking up so definite a position is, that when you view the subject from a wider standpoint, you will find that the molar teeth are just as well erupted when there is no antrum at all. Perhaps the instance in which this is most apparent is in the baboon. You can convince yourselves by the inspection of the specimen which I have brought that in that ape there is no antral cavity so called, and yet that there is a general resemblance in the architecture in the face of this beast to that of man. It seems to me that one is, with equal logic, justified in saying that the activity of the dental germ is in itself sufficient justification for the expansion of the antrum. As regards any function that the antrum may have, there has always been a difficulty. We have had to rest content with the suggestion that it is intimately associated in some way with phonation. If it be necessary to provide the antrum with some function other than that of merely lightening the bulk of the bone, I would almost be inclined to suggest that possibly it acted as an air space which it utilised as an efficient non-conductor. This would prove of service in maintaining the temperature of the blood circulating in the mucous membrane overlying the nasal conchae, an arrangement which I have elsewhere referred to in connection with the function of the nose as a heating apparatus to raise the temperature of the external air before it reaches the lungs (see *Journal of the Anthropological Institute*, vol. liii, 1923). The most important point to consider, as it seems to me, in regard to the architecture of the maxilla, is to think of the inner and outer walls of the antrum, the inner wall being the nasal wall, and the outer the facial wall. It must be through one or other of these walls that the pressure exercised by the teeth when powerfully opposed, must be transmitted. Either one or the other, or both, of these walls, supporting as they do the alveolar border on which the teeth are set, must bear the pressure thrown on them, and obviously the pressure will vary according as the teeth are set in relation to one or other of these walls.

The next consideration is the matter of the muzzle. Again referring to the morphological baseline, the cranio-facial axis, we have the brain-containing part of the skull above and behind, and the muzzle in front and below. Now I ask you to examine a few typical mammals and see what happens. Take, for example,

the dog (Fig. 6) or the pig, or the horse (Fig. 7). You will notice the small provision for the brain behind the cranio-facial axis, and the great expansion of the muzzle in front of that line. I want you to look particularly at the position of the orbit. The orbit lies behind the muzzle, and the orbital margins are incomplete posteriorly, except in the case of the horse, of which mention will be made hereafter.

FIG. 6.—Drawing of the skull of a dog, showing by means of the dotted line where the muzzle at its stoutest part has been sectioned. The outline to the right exhibits the appearance displayed in the cut surface of the cranial half of the skull.

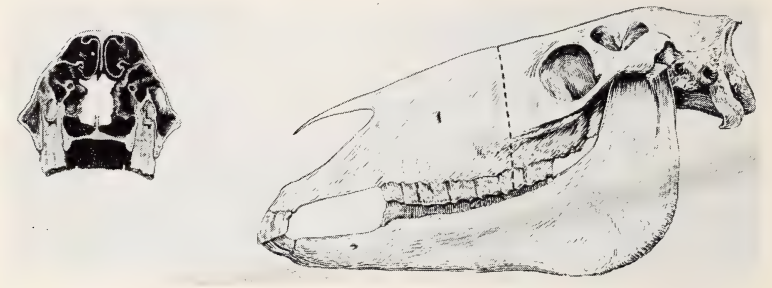


FIG. 7.—Drawing of the skull of a horse. The dotted line indicates where the section was made. This was selected because the bones of the muzzle here seemed stoutest. The figure to the left represents the appearance of the cut surface of the muzzle end of the skull.

If you take such a skull as that of the pig, you will notice that as the brain increases in size, so the orbit comes forward and acquires a higher position. I show you another example in the case of the baboon (Fig. 8), where there is still a good-sized muzzle, associated with a bigger brain case, and the orbit has now risen to occupy a position above the muzzle. Note what this change involves. It brings about an alteration in the relation of the posterior orbital circumference, which has now become an external orbital margin. The more this change in position takes place, the more complete

becomes the external orbital margin, until, as in the baboon and the orang, the orbital cavity is completely cut off from the temporal fossa, conditions apparently associated with a reduction in the size of the muzzle and an increase in the capacity of the cranial cavity. In man, with the further reduction in the muzzle and the great increase in the size of the cranial cavity, the external margin of the orbit becomes extremely well-developed. What is the reason for this? It is best explained by further reference to the skull. In the lower forms, the canines are enormously developed; apart from the consideration of the general reduction in the size of the teeth in man, the most important factor is the small relative size of the canines. Let me remind you that these are hooking, holding, and lacerating teeth. Disposed as they are, near the extremity of the mandibular lever, they can exercise but a relatively slight crushing pressure. The arrangement of their roots confirms this view. On the other hand, you will notice, if you take the skull of a dog, and look at it carefully, that the upper jaw is most stoutly and strongly developed opposite the carnassial tooth (Fig. 6). It is at that point that the construction of the bone is best fitted to bear the crushing pressure. You will notice that the strongest

FIG. 8.—Drawing of the skull of a baboon, showing line of section (dotted). To the right is seen the appearance of the cut surface of the cranial half of the skull.

part of the maxilla lies in front of the orbit, and that the posterior orbital wall and margin is deficient, whereas in man its comparable part, the *external orbital margin*, is stoutly developed. You will find, if you examine a series of mammalian skulls, that, with the reduction in the size of the muzzle, the strongest part of the maxilla gets closer to the orbit, and that the orbital aperture becomes directed more forward than outward, and that its margins, in place of being anterior and posterior in position, now come to lie internally and externally in relation to each other. Finally, you find that, when the canines have become small and unimportant, and have been dispensed with as weapons of offence and defence, the main force of the bite having been shunted on to the molars, the strongest part of the jaw, which will naturally have to resist the crushing strain, will fall in line with what we term the external orbital margin, which is, morphologically, the same margin as, in the dog, we call the posterior orbital circumference. In the dog's skull you will see there is no posterior orbital wall (Fig. 6). If a transverse section of a dog's skull be made passing through the

carnassial tooth on either side (Fig. 6), it is here that the structure of the maxilla will exhibit its stoutest development. You will notice that here the arrangement of the bones of the muzzle has a resemblance to a Gothic arch, of which the pillars correspond to the alveolar border in which the teeth are set, the summit of the arch being formed of the stout and thick nasal bones. As will be seen in the section, the bones within the arch are feebly developed. The hard palate forms a tie which prevents the spread of the arch, the whole serving as an admirable arrangement to withstand the pressure transmitted through the teeth.

In the horse (Fig. 7), the orbit is not formed in the same way as in the dog. It has a complete bony circumference, formed, as Flower points out, in an unusual way, by the union of the external orbital process of the frontal with the squamosal part of the temporal and *not with the malar*. This is an arrangement made, no doubt, to afford additional strength to the attachment of the massive masseter muscle. In this case, also, the coronoid process of the mandible is elongated and recurved whilst the temporal muscle is small, and consists of short fibres, an arrangement which supports the view I expressed earlier in the lecture, that in this case we have a muscle well adapted to furnish the rapid movements involved in nibbling grass.

The strongest part of the maxillæ lies in front of the orbit. When viewed in section, the enormous teeth are seen set in between the inner and outer walls of the antral space, and not in correspondence with the outer wall as shown in the dog, so that the pressure is in part distributed through the inner as well as the outer walls of the body of the maxilla, a circumstance which accounts for the greater thickness of the bony partitions occupying the interior of the muzzle. There is also an ingenious arrangement whereby the canal which transmits the infra-orbital nerve serves as a tie to unite the other parts of the bone, and thus provides a remarkably strong framework, which, though delicate in structure, is obviously well designed to withstand pressure. In the baboon (Fig. 8), there is no antral cavity at all. In place of it, there is a thin and wide flange of bone which materially strengthens the osseous structure. In section, the teeth are seen lying just below the outer wall of the maxilla, which is here reinforced by the thin flange of bone above referred to. In the orang (Fig. 9) the size of the muzzle is somewhat reduced by the forward expansion of the cranial cavity above and behind. In this case, the strongest part of the maxilla corresponds to the spring of the pyramidal eminence, which, in man, we call the zygomatic process. It is this part of the bone which forms the buttress on which the malar or zygomatic bone rests. The lower edge of the zygomatic process may be referred to as the zygomatic crest of the maxilla, and in this instance it will be seen to fall in line with the interval between the first and second molar teeth. If a vertical transverse section be made through the maxilla in this plane, the stoutness of the bone along the line of the outer wall of the body of the maxilla will be observed, and a considerable thickening of the inner antral wall will also be noticed. The stout outer wall of the maxilla becomes continuous, above, with the compact tissue of the malar bone, through which the pressure is conducted along the outer orbital wall to the supraorbital margins, which are here strongly reinforced and united to each other in the middle line by the dense

bone underlying the glabellar region—which bone, be it noted, extends down between the orbital cavities where it blends below with the inner antral walls, here more than usually stout. I wish especially to direct your attention to this arrangement, for, as you know from experience, one of the commonest mistakes the beginner makes in handling human skulls is to lift them by inserting the thumb and forefinger into the orbital cavities. The results of this procedure are apt to be disastrous, for in man the bones which occupy the interorbital interval are so thin and delicate that they are apt to be crushed and broken. Not so in the case of the apes, for there the lachrymals and ethmoid are much more stoutly developed, and will resist very considerable pressure when applied to them. This all seems to point to the conclusion that in the apes the inner antral walls, and the bones which occupy the interorbital interval, bear a part in resisting the pressure to which this part of the face is subjected when the teeth are forcibly used.

FIG. 9.—Drawing of the skull of an orang, showing dotted line of section ; to the right is seen the appearance of the cut surface of the cranial half of the skull.

In comparing a vertical transverse section of the facial skeleton in man (Fig. 10), made in much the same plane, certain noticeable differences will be remarked as compared with the appearances displayed in the orang. The line of stoutest bone will be traced from the alveolar border along the outer antral wall to the malar or zygomatic bone, through which it passes to be continuous with the stout external orbital margin, whence it passes to the external angular processes of the frontal. But here a difference is at once observed, for in place of the pronounced and compact supraorbital margins displayed in the orang, the conditions are altered by the forward bulge of the greatly expanded cerebral envelope, whereby the frontal squama now occupies a more vertical position, and is in consequence better fitted to withstand a vertical pressure than when, owing to the existence of a lesser cranial capacity, it occupied a more sloping position. In the latter case it had obviously to be reinforced at the supraorbital margins to withstand the upward

thrust. In the illustration given, where the cranial capacity is large, the frontal squama, now nearly vertically disposed, absorbs much of the pressure.

In the higher races of man, owing to the relief given in this way to the upper orbital margins, to enable them to withstand the pressure to which they are subjected, we find a complete absence of a supraorbital torus. It is only in the more lowly forms, where the cerebral development is small, and in consequence the frontal squama more oblique in position, that we recognise the massing of bone in this situation as necessary. This observation is borne out by the appearance displayed by the Australian and Neandertal types, and further emphasised by the characteristic features exhibited by the anthropoid apes.

A further feature of interest which the section of the facial skeleton displays, is that the bones occupying the interorbital interval and limiting the extent of the nasal fossæ are on the whole much weaker and not so stoutly developed as the corresponding bones in the apes. This may possibly be due to the fact that, owing to the altered condition and the greatly increased size of the cranial cavity, they are not now called upon to bear a share in resisting the upward pressure. We have already seen how closely face projection in man is associated with size of teeth. Other things being equal, we know that big-toothed races are prone to be prognathous, whilst small-toothed people exhibit the straightest faces. Naturally the size of the teeth will determine the point of greatest pressure, and consequently react on the structural arrangement to meet it. It is interesting to see what confirmation of this we meet with in our researches. Referring to the pyramidal zygomatic process of the maxilla of which the lower border, as I said, might be called the zygomatic crest, it is noteworthy that its fusion with the body of the bone will vary in different individuals and races according to the size and arrangement of the teeth. The importance of this observation depends on the fact that it is through this crest that the main part of the pressure is transmitted upwards through the malar bone on to the external orbital margin. It is therefore of some interest to note the variations in respect of position of these osseous points, viz. (1) the zygomatic crest, and (2) the external orbital margin, to the molar teeth.

To my assistant, Miss Beatrice Blackwood, B.Sc., I am indebted for the following notes. In the 277 skulls examined, the zygomatic crest of the maxilla was situated, in descending order of frequency, between the first and second molars, over the second molar, or over the first molar. Certain interesting racial differences also became apparent. In prognathous skulls the zygomatic crest lies most frequently over the second molar with a bar of bone running obliquely down to the alveolar border over the first molar.

In the table which follows these have been counted as over the second molar. The change noted in modern English as compared with ancient British skulls is interesting.

Referring again to the supraorbital region in man, it is clear that this is formed by the fusion of the supraorbital margins with that part of the frontal squama which overlies the frontal lobes of the brain. Morphologically, the frontal bone is in part a bone of the face as well as of the cranial vault, the position of the ophryon —a variable point corresponding to the centre of the least transverse width between the frontal temporal crests—serves to indicate

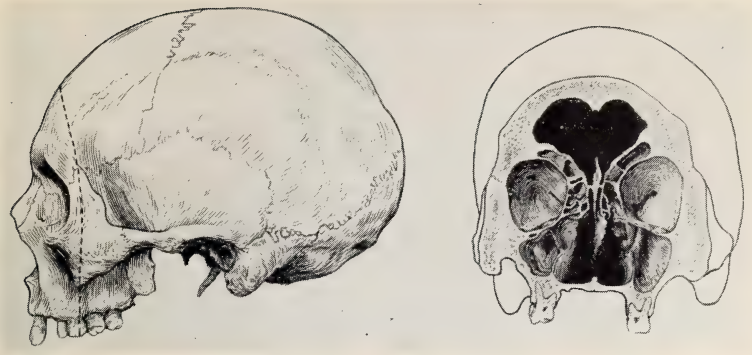


FIG. 10.—Drawing of a human skull, displaying the appearance of the section of the hinder half of the skull. The dotted line on the left hand figure indicates the line of section.

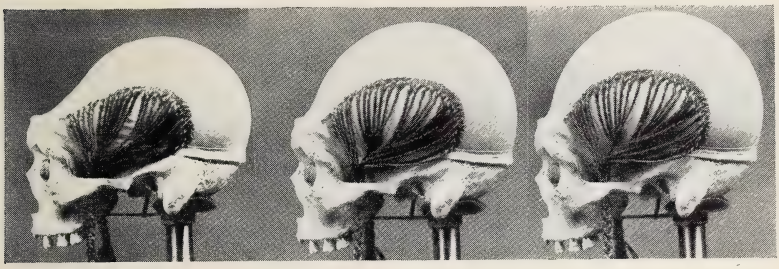


FIG. 11.—Photographs showing the appearances displayed when an india-rubber balloon cemented on the *same cranial base* is distended by varying degrees of inflation with air.

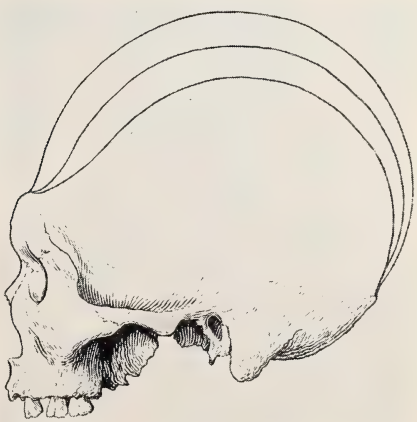


FIG. 12.—Diagram representing in three outlines on the same cranial base the contours displayed by the inflated balloon in different degrees of distension.

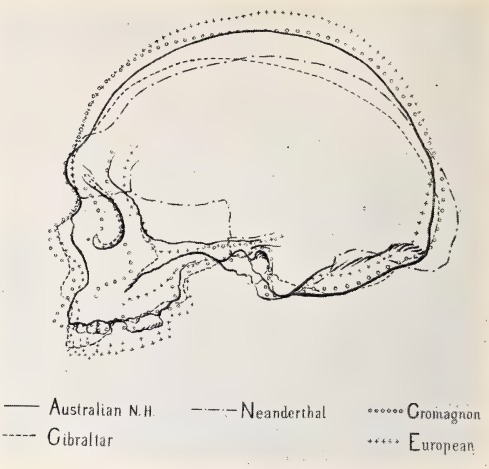


FIG. 13.—Diagram compounded of the outlines of the skulls enumerated, oriented on a cranio-facial axis of the *same length*, disposed at an angle of 27° with the horizontal.

TABLE I.

Showing position of zygomatic crest of maxilla in relation to molar teeth.

Group.	Over I molar. Actual No.	Over I molar. Per cent.	Between I & II molar. Actual No.	Between I & II molar. Per cent.	Over II molar. Actual No.	Over II molar. Per cent.
28 Negroes and Australians ...	3	10.7	9	32.1	16	57.1
45 Chinese	9	20.0	27	60.0	9	20.0
47 Eskimo	19	40.4	15	31.9	13	27.6
19 Indians (Calcutta) ...	9	47.4	6	31.6	4	21.0
53 Ancient British ...	27	50.9	12	22.6	14	26.4
14 Mediæval English ...	9	64.3	2	14.3	3	21.4
71 Modern English ...	10	14.1	25	35.2	36	50.7
277 Total number of skulls examined.	86 or	31.1%	96 or	34.7%	95 or	34.1%

The external orbital margin lies, in the majority of skulls examined, over the second molar tooth or between it and either the first or the third, but in certain cases it is found to be situated as far forward as the first molar, or as far back as the third. It lies, as a rule, slightly behind the zygomatic crest, but may, especially in Chinese skulls, be situated immediately above it. The analysis of the figures is shown in the following table.

TABLE II.

Showing position of external orbital margin in relation to molar teeth.

Group.	Over I molar. No.	Over I molar. Per Cent.	Between I & II molar. No.	Between I & II molar. Per Cent.	Over II molar. No.	Over II molar. Per Cent.	Between II & III molar No.	Between II & III molar Per Cent.	Over III molar. No.	Over III molar. Per Cent.
27 Negroes & Australians	3		3	11.1	16	59.3	8	29.6		
45 Chinese ...	5	11.1	11	24.4	23	51.1	6	13.3		
38 Ancient British			12	32.4	21	54.1	5	13.5		
14 Mediæval English			7	50.0	6	42.9	1	7.1		
72 Modern English			9	12.5	32	44.4	25	34.7	6	8.3
196 Total No. skulls exam.	5	2.5	42	21.4	98	50.0	45	23.0	6	3.1

the line of separation between the two parts. Below it are situate the parts of the bone which enter into the composition of the face and which comprise the two superior orbital margins, whilst above it lies that part of the frontal squama which covers the anterior lobes of the cerebrum. The two together constitute what in man we term the forehead. The anthropoids, with the possible exception of the orang, have no forehead, for in them the facial and cranial parts of the frontal bone are separated by a wide furrow which, throws into relief the supraorbital arches and interrupts the surfaces continuity of these with the cranial part of the bone.

An examination of the mesial longitudinal sections of the skulls of the orang, gorilla and man (Fig. 1) will reveal how, by the gradual expansion of the cranial cavity, this apparent independence of the two parts is obliterated, so that, in man, there is little or no evidence to show their functional relationship. An examination of the crania of fossil man as well as the conditions displayed in the lowlier types of man now living, clearly prove that the evolutionary forces at work are mainly concerned with the expansion of the cranial envelope to accommodate a larger brain which, by its more or less complete fusion with that part of the frontal bone which is more intimately concerned in the construction of the face, leads to the production of those remarkable differences which are met with in the supraorbital region of the more primitive types of mankind. These differences, despite the views of Schwalbe and others in respect of the characters of the Neandertaloid crania, are not specific, but are merely stages in the evolutionary processes by which the higher and bigger-brained type has been evolved.

Some years ago I addressed myself to this problem and delivered an address at the International Medical Congress at Madrid wherein I endeavoured to illustrate the process in a more or less experimental way. By many the results were considered more amusing than interesting. To be frank, I did not then realise their importance as I do now, for I had not then acquired such an insight into the arrangement of the facial skeleton as I now possess. Let me briefly recall the nature of the experiment. A skull was taken from which the sides and summit of the cranial cavity were removed leaving only the basal part, in other words that part of the calvaria which is developed in cartilage, in contra-distinction to the bones of the sides and vertex which are developed in membrane. It is common knowledge that the latter, being much more plastic, are subject to the influence of pressure continuously applied during the active period of growth, as is proved by the resulting deformations induced by the application of boards or bandages, practised for æsthetic reasons by some tribes of American Indians.

On the upper surface of the basal part of the skull, from which the sides and dome of the "skull cap" had been removed, an india rubber ballon was securely cemented, care being taken to allow the neck and orifice of the balloon to fall through the foramen magnum, so that the nozzle of a bicycle pump could easily be inserted into it, an arrangement which permitted the balloon to be easily inflated or deflated. The illustration given (Fig. 11) represents the specimen with the balloon distended in varying degree. It became at once apparent that by altering the amount of the distension of the balloon we could simulate the appearances displayed in the anthropoid apes, passing by successive stages to those characteristic of primitive man, and lastly exhibiting the

conditions which we associate with modern man. These changes, being induced by the varying degrees of distension of the balloon, were in this respect comparable to the processes of nature, whereby an increase in the bulk of the brain leads to a necessary alteration in the expansion and form of the osseous cranial envelope.

The results, so far as we are at present concerned, may be best realised by a glance at the accompanying illustration (Fig. 11) which is reproduced from the original paper. At the same time I would like to add that the other results obtained by this method were as remarkable, for it was clearly demonstrated that when a moderate amount of air was injected into the balloon cemented on to the same skull base, the form displayed by the specimen when viewed in the *norma verticalis* was of the dolichocephalic type, whereas when the amount of air was increased, in other words when the cranial capacity was made bigger—and that, be it noticed, on the same base length—the specimen assumed all the characters of a brachycephalic type of skull.

To return however to the matter in hand. The diagram (Fig. 12) I show you, exhibits, in outline form, three tracings of the same experimental skull. One of the outlines shows the form displayed when viewed in the *norma lateralis*, with the balloon but slightly inflated, the next exhibits the appearance when the balloon is moderately distended, the third and highest outline represents the shape of the head when the balloon is well filled. Each of these outlines may then be regarded as comparable to the change induced by an increase in the amount of the cranial capacity.

Thus, taking the lowest of the three outlines, it will be observed that the ape-like characters of the frontal region are well represented, due, as here proved, to the feeble expansion of the cranial cavity. When this latter is increased, the isolation of the supraorbital part of the frontal bone from that part of the frontal squama which is more directly associated with the cranial cavity becomes less apparent, whilst when the cranial capacity is still further enlarged, the elevation of the frontal squama leads to its more complete confluence with the supraorbital portion of the bone, thus producing the forehead which is so characteristic of the higher types of mankind. To enable you to realise the significance of these changes, let me ask you to compare with Fig. 12, a diagram (Fig. 13) compounded of the outlines of some living and some fossil types of man, noting for the time being that only these examples of fossil man have been included in which it has been possible to estimate the position of the cranio-facial axis.

To me it seems that the comparison of the outlines of the two figures (Fig. 12 and Fig. 13) in the frontal region are so striking, that we are left with no alternative but to accept the view that the form of the lower frontal region in man is determined by the interaction of cranial expansion on the one hand, combined with the necessity of providing adequate resistance to withstand the pressure which, as has been already explained, is transmitted in man through the external angular processes of the frontal bone to the supraorbital arches. It is with some degree of confidence that I leave the consideration of this question to your impartial judgment.

The minutes of the previous ordinary meeting were read and confirmed.

The CHAIRMAN declared elected the officers and Councillors nominated by the Council. As no private nominations had been received, a ballot was not necessary.

Mr. B. SAMUEL proposed the election of Mr. R. Bout-Wood as auditor. This was seconded by Mr. STRICKLOW and agreed to.

Mr. NORTHCROFT proposed Mr. A. Garrow as second auditor. This was seconded by Mr. BADCOCK and agreed to.

REPORT OF THE HON. TREASURER.

I have the pleasure to report that the total income of the Society for the past year amounted to £219 11*s.* 2*d.*, including £5 18*s.* 4*d.* interest on investments, and the total expenditure to £192 7*s.* 6½*d.*; leaving on the year's working a net balance of £27 3*s.* 7½*d.*, and making with last year's balances and the sum of £150 in Government securities redeemable at par a total credit balance of £200 17*s.* 10*d.*; the available bank balance being £49 18*s.*

Mr. STEADMAN proposed the adoption of the Report, Mr. CAMPION seconded, and this was agreed to.

REPORT OF THE HON. CURATOR.

Mr. President, I regret that owing to indisposition I have been prevented from securing for the museum several specimens which had been promised; one, however, of interest has been made by Mr. Lewin Payne, a series of models showing a boy's teeth from the age of two and a half years up to eleven, and I may say he hopes to continue this particular series. If any members who have similar series in good condition would present them to the museum, I should be very glad to receive them.

Mr. FRIEL proposed and Mr. STEADMAN seconded its adoption, and this was agreed to.

REPORT OF THE HON. LIBRARIAN.

During the current year the members of the Society have made increasing use of the Library, several new volumes have been acquired and a certain number of pamphlets and transactions have been bound. The Librarian would remind members that the Council are always ready to receive suggestions for new books to be acquired, and that he is always prepared to forward members any books from the library they may desire on loan.

Mr. HIGHTON proposed and Mrs. LINDSEY seconded its adoption, and this was agreed to.

REPORT OF THE HON. SECRETARY.

The usual number of meetings have been held during the year. An important feature was the address by Dr. Georges Villain, of Paris, "The Mechanism of the Human Denture and Physiological Orthodontic Treatment." Papers were read by Messrs. W. W. James, Edward D. D. Davis, W. H. Dolamore and D. M. Shaw, and this evening Professor Arthur Thomson will speak on "Facial Development." During the past year the demonstration meeting was omitted, but a new and successful feature, introduced on the initiative of the President, were papers by two of the younger members, Messrs. Charles and Packham, at the November meeting; it is hoped that this may be an annual item on the programme. The attendance at the meetings has been very good. The number of new members elected during the year is seventeen, and five have resigned, leaving a total membership at January 1st, 1924, of 162. I think we may say with confidence that the Society continues to flourish, and the statements in regard to the meetings and membership are evidence of the interest taken in it The Report of the Education Committee has been published since the

last annual meeting and was well received. The Council has kept this Committee in being and it meets again to-morrow.

Committees are also considering the following matters :—

1. The offer of prizes by the Society for open competition.
2. Nomenclature.
3. Investigations of orthodontic problems by the members individually.

By taking up these various problems the Society is justifying its name and hopes to foster study among an ever widening circle with a corresponding increase in our knowledge of orthodontics.

The CHAIRMAN said that Mr. Chapman's Report had in no way conveyed the enormous amount of work which he (Mr. Chapman) himself did for the Society. He wished to propose from the chair that the Report be received and adopted.

This was agreed to.

Mr. BADCOCK said he thought the Society would like to express its sympathy with Mr. Maxwell Stephens in his recent serious illness and its satisfaction of knowing that he was on his way to recovery. He moved : " That the Secretary be asked to write him to that effect."

Mr. NORTHCROFT seconded, and the motion, which was endorsed from the chair, was agreed to unanimously.

The following candidates approved by the Council were elected to membership : N. M. McArthur Douglas, L.D.S., R.C.S.Eng., Isle of Man ; C. D. Farris, L.D.S., R.C.S.Eng., London.

At the close of the meeting the CHAIRMAN inducted the new President, Mr. SHELDON FRIEL, amid applause.

Mr. FRIEL thanked the members for the honour they had done him. When he looked at the roll of former Presidents of the Society he was conscious of his own unfitness for the position. He said he would endeavour to attend the meetings of the Society as regularly as possible, but unfortunately he lived on the other side of a narrow sea—the Irish Sea—which occasionally like that nation, became fractious. He was sensible of having received the greatest honour possible in British orthodontics.

Mr. NORTHCROFT proposed a hearty vote of thanks to the retiring President for his work during the year. The Society had prospered under his genial Presidency, and he only wished that he (Mr. Warwick James) could have been there that evening to have delivered his Valedictory Address.

This was put from the chair and carried unanimously.

Mr. BADCOCK moved a hearty vote of thanks to the Secretary, Treasurer and Officers for the work they had undertaken during the year. The work could not have been better done and the members of the Society were very grateful to them.

This also was carried by the Society and the meeting terminated.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS.

STATEMENT OF ACCOUNTS, December 1st, 1922, to November 30th, 1923.

1921-22.			ASSETS.			1922-23.		
£	s.	d.				£	s.	d.
150	0	0	To Government Securities (at par)	...		150	0	0
42	8	2	Cash at Bank	...		22	0	6
1	3	3	Cash in Hand	...		1	19	10
5	14	1	Interest on Securities	...		5	18	4
			Sale of Exchequer Bonds ...	...		51	19	10
151	2	10	Members' Subscriptions ...	...		161	13	0
£350	8	4				£393	11	6

1921-22.			EXPENDITURE.			1922-23.		
£	s.	d.				£	s.	d.
15	15	0	By Rent	...		15	15	0
7	7	0	Hire of Epidiascope	...		6	6	0
1	10	0	Special Council Meeting ...	...				
			Delegate to Lyons Conference	...		8	10	0
			Purchase of War Loan ...	...		50	14	3
33	12	11	Printing	...		24	1	11
50	3	0	Transactions	...		44	0	0
24	3	0	Reporting	...		17	17	0
11	19	6	Librarian	...		9	14	6
6	6	0	Curator					
5	2	1	Petty Cash	...		6	13	10½
8	15	0	Refreshments	...		8	15	0
11	14	6	Typing and Refunded Subscriptions					
176	8	0				192	7	6½
150	0	0	Securities	...		150	0	0
22	0	6	Cash at Bank	...		49	18	0
1	19	10	Cash in Hand	...		1	5	11½
£350	8	4				£393	11	6

We have examined the Books and Vouchers and certify the above Statement of Accounts to be correct.

(Signed) J. W. MAYER,
A. L. PACKHAM,
Hon. Auditors.

British Society for Study of Orthodontics.

List of Members, 1923.

ORDINARY AND CORRESPONDING MEMBERS.

Achner, Conrad A., 47b, Welbeck Street, W.1.
Aldred, Alex. B., 359, Brixton Road, S.W.
Allen, Arthur G., 128, Queen's Road, Bayswater, W.
Aubrey, H. P., 83, Portland Place, W.1.

Badcock, G. W., 32, Brunswick Place, Hove.
Badcock, J. H., 140, Harley Street, W.
Bailey, E. R., 40, Trinity Road, Wandsworth, S.W.18.
Baldwin, Sir H., 37, Cavendish Square, W.1.
Barrett, Russell, 41, Harley Street, W.1.
Bascombe, E. D., Melford Lodge, Bourne Avenue, The Square, Bournemouth.
Bennett, F. J., 23, Grosvenor Street, W.1.
Bennett, Norman G., 50, Brook Street, W.1.
Blaaberg, C. J., 29, Queen Anne Street, W.1.
Boutwood, R., 23, Welbeck Street, W.1.
Bowes, J. A., 28, South Side, Clapham Common, S.W.
Briault, E. H. L. 145, Finchley Road, N.W.
Bryan, Hermann, 26, St. Giles's Street, Norwich.
Bull, F. B., 58, Wimpole Street, W.1.
Bulleid, W. A., 1, Burlington Gardens, W.1.
Butchart, Jas. S., High Mead, Bolton Crescent, Windsor.
Buxton, J. L. Dudley, 38, Harley Street, W.1.
Byron, J. L., 213, North End Road, Kensington, W.14.

Campion, G. G., 264, Oxford Road, Manchester.
Campkin, Hugh T., 71, Harley Street, W.1.
Chapman, Harold, 15, Upper Wimpole Street, W.1.
Charles, S. Wilson, Devonia, Rickmansworth, Herts.
Claremont, L. E., 5, Rodney Place, Clifton, Bristol.
Clarence, Thomas H., 24, Upper Wimpole St., W.1.
Clarke, J. F. H., 52, Shaftesbury Avenue, W.1.
Clogg, Arthur H., Rockmount, 128, Church Road, Upper Norwood, S.E.19.
Coe, W. E., St. Norman's, Streatham Hill, S.W.
Commander, Eric N., 11, Aldergate, Tamworth.
Crane, Walter A., Melford Lodge, Bourne Avenue, The Square, Bournemouth.
Cribb, H. E., 15, Stratford Place, W.
Croke, Augustin E., Sussex House, Guildford.
Cross, A. B., 11, Buckingham Gate, S.W.1.

Davie, Melville, 6, Carlisle Parade, Hastings.
Davis, E. D. D., 46, Harley Street, W.1.
Denham, N., 29, Albemarle Road, Beckenham.
Dickens, D. T. G., Wellington House, 175, King's Road, Reading.
Doherty, J. W., 140, Harley Street, W.1.
Doubleday, F. N., 48, Welbeck Street, W.1.
Douglas, M. N. McArthur, 1. Albert Terrace, Douglas, Isle of Man.
Dowsett, E. B., 118, Gloucester Place, Portman Square, W.1.
Dreyfus, S., 16, Grand Pont, Lausanne, Switzerland. (Corresponding Member.)

Eady, Barrington, 29, Devonshire Place, W.1.
Edey, G. Russell, 153, High Street, Bromley.
Edgar, N., 89, London Road, Enfield.

Farris, C. D., 42, Burnt Ash Road, Lee, S.E.12.
Fernie, J. G., Holmleigh, Murray Road, Northwood, Middlesex.
Fisk, Sidney W., Street Lodge, Essex Rd., Watford.
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Fox, Reginald A., 13, Wetherby Gardens, S.W.3.
Friel, Sheldon, 3, Fitzwilliam Place, Dublin.
Fry, W. Kelsey, Guy's Hospital, S.E.1.

Gardner, Stanley M., 24, Upper Wimpole Street, W.1
Garrow, A., 115, Harley Street, W.1.
Goldie, George J., 14, Upper Wimpole Street, W.1.
Grayson, J. Kenneth, Mount Pleasant, Turner's Hill, Cheshunt, Herts.
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Henry, P. F., 79, King William Street, E.C.4.
Highton, Herbert C., 17, Harley Street, W.1.
Hopson, Montagu F., 7. Harley Street, W.1.
Hudson, J. A., 67, High Street, Aylesbury, Bucks.
Hughes, T. Martin, Lister House, Broomfield Lane, Hale, Altrincham.

James, W. W., 2, Park Crescent, Portland Pl., W.1.
Jameson, Alfred, 18, Jesmond Road, Newcastle-on-Tyne.
Jameson, J. T., 12, Windsor Crescent, Newcastle-on-Tyne.
Jennings, E. A., 4, Queen's Walk, Ealing, W.5.
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Johnson, Gordon, 46, Lee Terrace, Blackheath, S.E.
Johnson, W. Trevor, 42, Sheep Street, Stratford-on-Avon.
Jones, Wm., 2, Colosseum Terrace, N.W.

Knaggs, S. A., 21, Rosslyn Hill, Hampstead, N.W.
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Lacey, A. G., 19, Harley Street, W.1.
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Lawrence, F., 35, Brompton Road, S.W.3.
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Lindsay, Mrs. L., 23, Russell Square, W.C.1.
Lindsay, Robert, 23, Russell Square, W.C.1.
Lockett, A. C., Hereford House, 117, Park St., W.1.
Lowe, E. W., 6, Brunswick Place, Hove.

McBride, John, 26, Duke's Avenue, Muswell Hill, N.
McKeag, H. T. A., 2, College Gardens, Belfast.
McKechnie, J. D., 29, Queen Anne Street, W.1.
McMahon, G. E., Connaught House, Beckenham, Kent.
Malleson, H. C., 30, Thurlow Rd., Hampstead, N.W.
Marsh, H. E., 1, Cantelupe Road, Bexhill, Sussex.

Marston, Allan T., 74, South Side, Clapham Common, S.W.4.
Mason, E. N., Sandown, 306, Broadway, Bexley Heath.
Matthews, G. F. Cale, 60, Newhall St., Birmingham.
Matthews, Trevor, 42, Sheep Street, Stratford-on-Avon.
May, W. J., 24, Upper Wimpole Street, W.1.
Mayer, J. W., Stedham House, Surbiton Hill.
Mellersh, W. Francis, 9, Harley Street, W.1.
Metcalf, H. F., 392, Upper Richmond Road, S.W.15.
Mendleson, B., 53, Queen Anne Street, W.1.
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Morris, L. F., West Moor, Poole Road, Bournemouth.

Newbald, L. J., 150, Carshalton Park Road, Carshalton, Surrey.
Newton, Sydney B., Brooklands, Uxbridge Road, Acton Hill, W.3.
Northcroft, George, 115, Harley Street, W.1.

Olver, S. Holloway, 42, Devonshire Street, W.1.
Ovey, William, 42, Gloucester Gardens, W.2.

Packham, A. L., 2, Park Crescent, Portland Place, W.1.
Parfitt, J. B., 179, King's Road, Reading.
Parker, Geo., 181, Edward Street, Brisbane, Australia.
Pavitt, P. G., 57a, Wimpole Street, W.1.
Payne, J. L., 18, Portland Place, W.1.
Payne, A. Ll. Spencer, Beechcroft, Colney Hatch Lane, Muswell Hill, N.10.
Pearce, F. J., 57a, Wimpole Street, W.1.
Pearce, R. Marson, 21, Oil Mill Lane, Kingston-on-Thames.
Phillips, Edward, 1, Frognal, N.W.3.
Philpots, Montague, 14, High Street, Windsor.
Pitt, Edward, Brandhoek, Gerrard's Cross, Bucks.
Pitts, A. T., 22, Wimpole Street, W.1.
Pollitt, G. Paton, 50, Brook Street, Hanover Square, W.1.
Pritchard, Geo. B., 18, Portland Place, W.1.

Rilot, Chas. F., 22, Wimpole Street, W.1.
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Rowlett, A. E., 165, London Road, Leicester.
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Sargent, V. F., 7, Harley Street, W.1.
Schelling, C., 37, Cavendish Square, W.1.
Scott, P., 42, Devonshire St., Portland Place, W.1.
Shore, H. D., 85, Gloucester Place, Portman Square.
Skipper, T. G., 52, Welbeck Street, W.1.
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Spiller, J. E., 62, Worple Road, Wimbledon.
Spokes, P. Sidney, Castle Place, High Street, Lewes.
Steadman, Sydney Francis St. Jermain, 9, Welbeck Street, W.1.
Stephens, B. Maxwell, 76, Grosvenor Street, W.1.
Stordy, Thos., 42, Claremont Road, Surbiton.
Strickland, J. H., 55a, Welbeck Street, W.1.
Sturridge, Ernest, 29a, Wimpole Street, W.1.

Tebbutt, E. Spencer, 30, Finsbury Square, E.C.2.
Thew, W., 14, Upper Wimpole Street, W.1.
Thomson, George, 142, Harley Street, W.1.
Toit, J. J. du, 11, Leevenovet Road, Tambverskloof, Cape Town.
Torrance, T. A., 29, Queen Anne Street, Cavendish Square, W.1.

Visick, Hedley, The Wolds, College Road, Eastbourne.

Wallace, Dr. J. Sim, 150, Harley Street, W.1.
Watkin, Harold G., 95, Durning Road, Liverpool.
Webb, W. T. Clarkson, 41, Wimpole Street, W.1.
Whittington, W. W., The Firs, Elm Road, Sidcup.
Wilson, A. G., 9, Sandyford Place, Glasgow, W.
Winderling, Prof. Aldo Maggioni, Via Manzoni 45, Milan, Italy. (Corresponding Member.)
Wood, Bryan J., 7, London Road, Kettering.
Wright, J. Snarey, 37, Cavendish Square, W.1.
Wright, Leslie D., 1, Wellfield Avenue, Muswell Hill, W.10.

HONORARY MEMBER.

Keith, Prof. Sir A., Royal College of Surgeons, W.C.1.

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